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Учебное пособие предназначено для студентов экологических специальностей и включает в себя аутентичные тексты по актуальным проблемам экологии, практические задания, направленные на создание необходимого лексического запаса, развитие навыков чтения специальной литературы, перевода специальных текстов, устной и письменной речи.

Пособие создано в соответствии с требованиями программы по английскому языку для неязыковых специальностей высших учебных заведений.

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ПРЕДИСЛОВИЕ

Настоящее пособие предназначено для студентов первого и второго курсов экологических специальностей с уровнем Intermediate/Upper-Intermediate и содержит аутентичные материалы и задания по английскому языку для специальных целей (ESP). Пособие составлено в соответствии с требованиями программы по английскому языку для неязыковых специальностей высших учебных заведений и может быть рекомендовано к использованию, как для аудиторной, так и самостоятельной работы.

Пособие состоит из двух разделов. Первый раздел включает в себя шесть уроков, которые содержат тексты для изучающего чтения, упражнения на отработку и закрепление новой лексики, словообразование, умение оперировать терминами, отработку навыков устного и письменного перевода, монологической и диалогической речи. Ряд упражнений предполагает творческое участие студентов и представлен в форме презентаций, докладов.

Второй раздел содержит тексты для дополнительного чтения, предназначенные для самостоятельной работы студентов.

В учебном пособии использованы оригинальные тексты из различных книг, пособий по специальности и электронных ресурсов.

Материалы пособия прошли апробацию в студенческих группах.

CONTENT

Part I.

UNIT 1. SUBJECT OF ECOLOGY

1.1 STUDY OF LIFE

PRE-READING

Task 1. Read the words correctly, mind the stress.

Biotic, physiology, discipline, temporary, analysis, generate, dynamic, conceptual, existence, establishment, species, investigate, diverse, emphasize, significant, crucial, sustainable, permanent.

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What is ecology?
2. What does ecology as a science deal with?
3. Who was the founder of ecology as a science?
4. Is it important to know the main problems of ecology and why?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

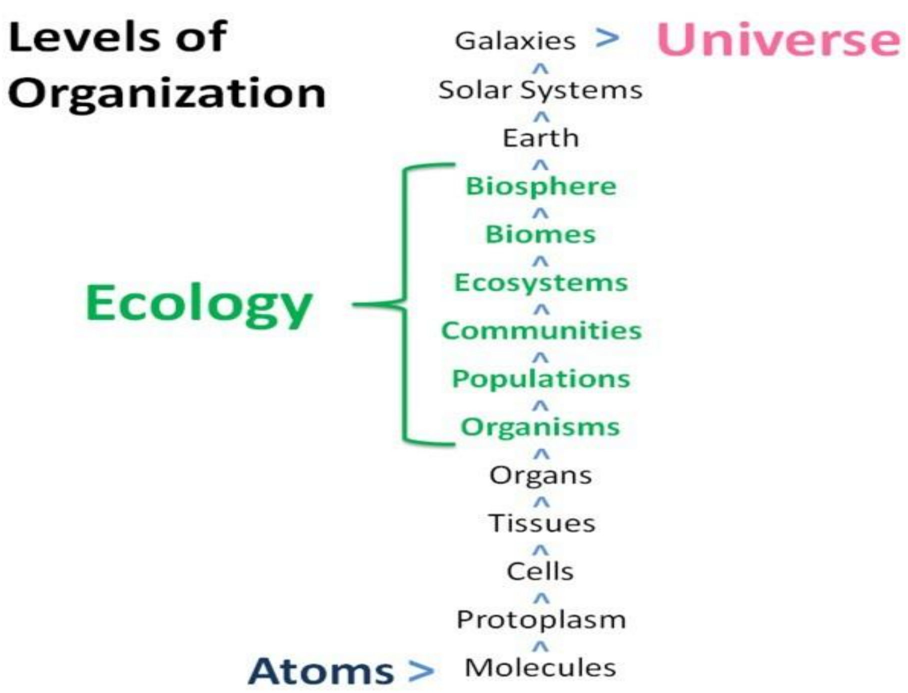
Ecology

Ecology is a sub-discipline of biology, or the study of life. Ecology is the division of scientific study focusing on organisms and their interactions with the environment. Ecology further researches and examines ecosystems and the network or relationships amongst all aspects of the environment. The term ecosystem refers to both the biological and physical elements within an environment. For example, physical components within an ecosystem consist of such elements as the soil and the land, while the biotic or living components include animals and plants. Ecosystems can be permanent or temporary and are always changing. Ecology examines such disciplines as the distribution of organisms within a given environment as well as the diversity, quantities and varieties of life in a particular habitat or ecosystem. Further studies in ecology focus on the movement of materials and flow of energy within groups of living organisms. Ecosystems are always changing and through ecological studies scientists and researchers can map and understand such changes to help us understand the world we live in.

The subject matter of ecology is normally divided into four broad categories: physiological ecology, having to do with the response of single species to environmental conditions such as temperature or light; population ecology, usually focusing on the abundance and distribution of individual species and the factors that cause such distribution; community ecology, having to do with the number of species found at given location and their interactions; and ecosystems ecology, having to do with the structure and function of the entire suite of microbes, plants, and animals, and their abiotic environment, and how the parts interact to generate the whole. This branch of ecology often focuses on the energy and nutrient flows of ecosystems, and when this approach is combined with computer analysis and simulation we often call it systems ecology. Evolutionary ecology, which may operate at any of these levels but most commonly at the physiological or population level, is a rich and dynamic area of ecology focusing on attempting to understand how natural selection developed the structure and function of the organisms and ecosystems at any of these levels.

There are many practical reasons for studying the discipline of ecology. Knowledge gained from ecological studies can be useful in such areas as wetland and resource management, city planning or urban ecology, as well as human ecology or the understanding of humans and social interaction. Long-term ecological studies provide a conceptual framework for understanding ecosystems over periods of time and space. The components comprising ecological studies can be as small as singular cells and as large as rainforest growth and decline over the period of a decade. Ecology embraces the conceptual belief that the world we live in is a whole comprised of many various parts and levels all working, changing and interacting together. Ecological studies typically organize these components into three levels or categories: organisms, populations, and communities. Populations are created by the interactions of organisms and communities by the interactions of populations. These individual parts change in relation to each other as well as in relation to time and space.

Levels of Organization of Ecology. (Credit: Erle Ellis)



The establishment of ecology as a field of biological science was first named in 1866 by the German biologist Ernst Haeckel. Haeckel coined the term ecology as referring to the study of all the complex interactions that are caused by the conditions of the struggle of existence. Other forefathers of the field of ecology include Carl Linnaeus who inaugurated a study known as the economy of nature that influenced the later works of Charles Darwin and Alexander von Humbolt who established the modern ecological law of species in regards to relationships to area. The environmental movement of the 1960s further spurred popularity in ecological studies. Charles Darwin's work, The Origin of Species, was one of the first documentations that looked critically at the corresponding and complementary relationships between organisms, their adaptations and changes in the environment. Darwin's work and increasing research in the field of ecology forever changed the way that researchers considered the ecological world. Many researchers were investigating such ideas during corresponding periods around the world and research regarding the history of ecology and its origin are still active fields of study today.

The environment and the lives of mankind are undoubtedly linked. Through ecological processes our planet Earth is able to provide us with air to breathe and food to eat. One of the most important and crucial components of our immensely diverse physical ecosystem is water. Water sustains all forms of life, therefore the management of this invaluable resource is of the utmost importance. Various fields and researches with the science of ecology strive to find the most effective ways to utilize and respect this resource. Many contemporary ecological studies emphasize the need to guarantee the stability and soundness of our ecosystem through sustainable water resource management. Ecological studies assist in finding ways to ensure that human activity and human use of water resources does not negatively affect or compromise the sustainability of aquatic resources and ecosystems over the long-term. Through these studies, solutions to water resource management can be established and further implemented. Contemporary ecological studies give high priority to the study of water as a prominent aspect and factor affecting all ecosystems and environments. Humans, animals and plants need water to survive and ecology helps us to learn how to use this precious resource appropriately.

Ecology studies the direct and undeniable link between all living things, time and space. Fundamentally, everything on earth depends on something else and can be affected by even the slightest change in our ecosystem. The scientific field of ecology and ecological studies helps us to understand this intricate and complex network of relationships. The effects that human beings have on the planet earth are substantial and significant and it is therefore crucial that we understand them in order to preserve our ecosystem for future animal life, plant life as well as our own future generations to come.

(Retrieved from: http://www.rususa.com/science/articles.asp-tc-ecology)

Vocabulary

- Permanent [ˈpɜːmənənt] – постоянный
- Network [ˈnetwɜːk] – сеть, цепочка, система
- Crucial [ˈkruːʃl] - ценный
- Diversity [daɪˈvɜːsəti] – разнообразие, многообразие
- Abundance [əˈbʌndəns] – изобилие, избыток
- Comprise [kəmˈpraɪz] – включать, содержать в себе
- Sustain [səˈsteɪn] – поддерживать, способствовать, обеспечивать
- Implement [ˈɪmplɪment] – воплощать в жизнь
- Intricate [ˈɪntrɪkət] – запутанный, сложный, замысловатый
- Substantial [səbˈstænʃl] – существенный, важный.

Word study

Task 3. Give the English equivalents for the following:

1.существование

2.попытка

3.местонахождение, положение, размещение

4.ухудшаться, уменьшаться

5.взаимодействие

6.сосредоточиваться, обращать внимание, концентрироваться

7.временный

8.ветвь, отрасль, ответвление

9.структура, строение, рамки

10.крайний, предельный, величайший

Task 4. Match the words with their appropriate meanings.

1. soil	a. количество
2. forefathers	b. ценный, важный
3. establishment	c. бороться, сражаться
4. natural selection	d. почва
5. quantity	e. разнообразный, различный

6. crucial	f. создание, учреждение, образование
7. urban	g. вид, разновидность
8. distribution	h. многообразие, разнообразие
9. species	i. предки, предшественники
10. struggle	j. заболоченная территория
11. diverse	k. распределение, распространение
12. wetland	l. естественный отбор
13. variety	m. городской

Task 5. With the help of your dictionary, make nouns out of the following verbs.

Divide, study, examine, distribute, vary, interact, select, develop, generate, exist, survive, investigate, analyse.

Task 6. Choose the best variant and complete the gaps.

1. Ecology is the_______of scientific study.
a. division
b. dividing
c. divide
2. Physiological ecology deals with the response of single species to ___________ conditions such as temperature or light.
a. permanent
b. environmental
c. ecological
3. Population ecology usually focuses ______ the abundance and distribution of individual species.
a. for
b. in
c. on

4. _______________ often focuses on the energy and nutrient flows of ecosystems.

a. Population ecology

b. Community ecology

c. Ecosystems ecology

5. ___________ is a rich and dynamic area of ecology focusing on attempting to understand how natural selection developed the structure and function of the organisms and ecosystems at any of these levels.

a. Evolutionary ecology

b. Population ecology

c. Community ecology

6. Ecological studies typically organize these components into three levels or categories:___________.

a. organisms, populations and communities.

b. cells, organisms, communities.

c. organisms, species, populations.

7. It is therefore crucial that we understand them in order to ______ our ecosystem for future animal life.

a. comprise

b. preserve

c. gain

Task 7. Give as many synonyms to the word as you can.

a. crucial

____

b. to focus

____

c. permanent

____

d. temporary

____

e. urban

____

f. establishment

____

g. interaction

____

h. diverse

____

Task 8. Fill in the table of the levels of organization.

Universe

↑

Galaxies

↑

………

↑

………

↑

Biosphere

↑

………

↑

………

↑

………

↑

Organisms

↑

Organ systems

↑

Organs

↑

Tissues

↑

………

↑

………

↑

………

↑

Subatomic particles

Task 9. Make up sentences. Mind the word order.

1. biology/ a/ of / ecology / sub-discipline / is
2. to/ “ecosystem” / an/ both/ biological and physical / refers/ the/ elements / environment/ term/ the/ within.
3. of/ often/ and/ ecology/ this/ on/ energy/ nutrient /focuses/ of / the/ branch/ ecosystems/ flows.
4. is/ and/ ecology / area/ rich/ dynamic/ of / evolutionary/ a/ ecology.
5. comprising/ as/ studies / the/ be / ecological/ small/ can/ singular/ as/ components/ cells.
6. these/ parts/ in/ to/ in/ change/ each/ as well as/ individual/ other/ relation/ time/ relation/ and/ space/ to.
7. the/ mankind/ the/ undoubtedly/ environment/ lives/ are/ and/ linked/ of.
8. and/ need/ humans/ water/ animals/ plants/ survive/ to.
9. effects/ on/ are/ human/ planet/ the/ earth/ have/ substantial/ that/ and/ the/ beings/ significant.

Comprehension and discussion

Task 10. Answer the questions.

1. What is ecology as a science?
2. What does ecology study and examine?
3. What are the categories of the subject matter of ecology?
4. What does the physiological/population/community/ecosystems ecology deal with?
5. What does the evolutionary ecology focus on?
6. Name the main levels of organization.
7. What are the practical reasons for studying the discipline of ecology?
8. When did the establishment of ecology start?
9. What was Haeckel’s definition of the term “ecology”?
10. Can you name other forefathers of the field of ecology?
11. What was the influence of Darwin’s work on the ecological world?
12. In what way are the mankind and environment linked?
13. Why is water one of the most crucial components of the world?
14. Why is the study of ecology so important for the human beings?

Task 11. Decide if these statements are true or false. Explain your opinion according to the text.

1. Ecology is a sub-discipline of Physics.
2. The term ecosystem refers to both the biological and physical elements within an environment.
3. Ecosystems can be permanent or temporary and never change.
4. The subject matter of ecology is normally divided into 3 broad categories.
5. The establishment of ecology as a field of biological science was first named in 1868 by the German biologist Ernst Haeckel.
6. Other forefathers of the field of ecology include Carl Linnaeus who inaugurated a study known as the economy of nature that influenced the later works of Charles Darwin and Alexander von Humbolt who established the modern ecological law of species in regards to relationships to area.
7. Alexander von Humbolt's work, The Origin of Species, was one of the first documentations that looked critically at the corresponding and complementary relationships between organisms, their adaptations and changes in the environment.
8. The environment and the lives of mankind aren't linked.

Task 12. Make up a dialogue with your partner. Ask each other questions about:

- the scientific definition of ecology;
- the subject matter of ecology;
- the main categories of ecology;
- the levels of organization;
- the establishment of ecology as a science;
- the reasons to study ecology;
- the importance of ecology in human's life.

Task 13. Speak on the given topic using the following words and word combinations:

1. Ecology as a sub-discipline of biology: scientific study, interaction, environment, permanent or temporary, examine, distribution, diversity, flow of energy, ecosystems.

2. The subject matter of ecology: physiological ecology, population ecology, abundance, distribution, community ecology, location, ecosystems ecology, entire suite , generate, nutrient flows, approach, systems ecology, evolutionary ecology, structure, function.

3. Practical reasons to study ecology: resource management, urban ecology, social interaction, conceptual framework, levels, in relation to.

4. The establishment of ecology as a science: forefathers, inaugurate, complementary relationships, adaptations, investigating, research.

5. The importance of ecology in the life of the mankind: invaluable, utilize, respect, emphasize, priority, prominent, precious resource, be affected, complex network, preserve.

Task 14. Choose one of the topics to make a report and present it in front of the class.

1. Ecology as a science.
2. The development of ecology as a science.
3. Ecology in our life.
4. The influence of the mankind on the environment.

1.2 ECOLOGY AS AN INTEGRATIVE DISCIPLINE

PRE-READING

Task 1. Read the words correctly, mind the stress.

Environmental, versus, components, discipline, connote, evaluative issue, normative, quality, ignorance, marine, benthic, nutrient, budgets, distribution, recently, measurement, appreciate, circle, pastures, dynamics, demography, implications, enormous, predicting, integrative, species, photosynthesis.

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. How are ecology and environment interrelated?
2. What are the reasons to study ecology?
3. What are the main areas of interest in ecology?

TEXT

Task 3. Read and translate the text.

Ecology

Ecology is the study of environmental systems, or as it is sometimes called, the economy of nature. "Environmental" usually means relating to the natural, versus human-made world; the "systems" means that ecology is, by its very nature, not interested in just the components of nature individually but especially in how the parts interact. Ecology is technically an academic discipline, such as mathematics or physics, although in public or media use, it is often used to connote some sort of normative or evaluative issue as in something is “ecologically bad” or is or is not “good for the ecology”. More properly ecology is used only in the sense that it is an academic discipline, no more evaluative than mathematics or physics. When a normative or evaluative term is needed then it is more proper to use the term “environmental”, i.e., environmental quality or “environmentally degrading”. Most professional ecologists are not terribly unhappy when ecology is used in the normative sense, preferring the wider public awareness of environmental issues today compared to the widespread ignorance of three decades ago.

Ecology is usually considered from the perspective of the specific geographic environment that is being studied at the moment: tropical rain forest, temperate grassland, arctic tundra, benthic marine, the entire biosphere, and so on. Thus you might study the population ecology of lions in an African savanna, an ecosystems study of a marine benthic environment, global nutrient budgets, and so on. The subject matter of ecology is the entire natural world, including both the living and the non-living parts. Biogeography focuses on the observed distribution of plants and animals and the reasons behind it. More recently ecology has included increasingly the human-dominated world of agriculture, grazing lands for domestic animals, cities, and even industrial parks. Industrial ecology is a discipline that has recently been developed, especially in Europe, where the objective is to follow the energy and material use throughout the process of, e.g., making an automobile with the objective of attempting to improve the material and energy efficiency of manufacturing. For any of these levels or approaches there are some scientists that focus on theoretical ecology, which attempts to derive or apply theoretical or sometimes mathematical reasons and generalities for what is observed in nature, and empirical ecology, which is concerned principally with measurement. Applied ecology takes what is found from one or both of these approaches and uses it to protect or manage nature in some way. Related to this discipline is conservation biology. Plant ecology, animal ecology, and microbial ecology have obvious foci.

There are usually four basic reasons given to study and as to why we might want to understand ecology: first, since all of us live to some degree in a natural or at least partly natural ecosystem, then considerable pleasure can be derived by studying the environment around us. Just as one might learn to appreciate art better through an art history course so too might one appreciate more the nature around us with a better understanding of ecology. Second, human economies are in large part based on the exploitation and management of nature. Applied ecology is used every day in forestry, fisheries, range management, agriculture, and so on to provide us with the food and fiber we need. For example, in Argentina in many circles there is no difference between ecology and agriculture, which is essentially the ecology of crops and pastures. Third, human societies can often be understood very clearly from an ecological perspectives as we study, for example, the population dynamics (demography) of our own species, the food and fossil energy flowing through our society. Fourth, humans appear to be changing aspects of the global environment in many ways. Ecology can be very useful to help us understand what these changes are, what the implications might be for various ecosystems, and how we might intervene in either human economies or in nature to try to mitigate or otherwise alter these changes. There are many professional ecologists, who believe that these apparent changes from human activities have the potential to generate enormous harm to both natural ecosystems and human economies. Understanding, predicting and adapting to these issues could be the most important of all possible issue for humans to deal with. In this case ecology and environmentalism can be the same.

Since ecology by its very nature is an integrative discipline, science students preparing themselves professionally in the field are encouraged to take a broad suite of courses, mostly in the natural sciences and including physics, chemistry, and biology of many sorts but certainly including evolution, meteorology, hydrology, geography, and so on. Ecologists interested in human ecology are encouraged to take courses and undertake readings in agronomy, demography, human geography, sociology, economics, and so on. Since ecology is so broad there are many things that an ecologist might wish to do and to train for. Today many ecology courses are taught in biology departments, where the focus is often on population or community ecology and also individual species.

There are a number of classical areas of interest in ecology, and they revolve around questions similar to the following: how much is the photosynthesis of a hectare of land? How many animals of what types might that photosynthesis be able to support as a base for their food resources? How many species might “divide up” the land or food resources available? How do the species present change as the physical conditions change, for example as one ascends a mountain? What is the proportion of food that is passed on from each food or “trophic” level to the next? What are the mechanisms that control the populations, communities and ecosystems in some area? How are human activities impacting these natural systems?

Ecology should be more than just a set of ideas and principles that one might learn in a classroom or book but rather more a way of looking at the world which emphasizes the assessment and understanding of how the pieces fit together, how each influences and is influenced by the other pieces and how the whole operates in ways not really predictable from the pieces. When we are lucky we are able to capture these relations in conceptual, mathematical or, increasingly, computer models that allow us some sense of truly understanding the great complexity of nature, including as it is impacted by human activity. This is the goal of most ecologists.

Hall, C. (2014). Ecology.

(Retrieved from: http://www.eoearth.org/view/article/151932)

Vocabulary

- Connote [kəˈnəʊt] – означать, подразумевать, иметь значение

- Derive [dɪˈraɪv] – получать, извлекать, происходить
- Appreciate [əˈpriːʃieɪt] – ценить, оценивать
- Fiber [ˈfaɪbə(r)] – волокно, древесное волокно
- Mitigate [ˈmɪtɪɡeɪt] – сдерживать, смягчать, облегчать
- Alter [ˈɔːltə(r)] - изменять, менять
- Revolve [rɪˈvɒlv] – вертеться, поворачиваться
- Impact [ˈɪmpækt] – влиять, воздействовать

Word study

Task 4. Make pairs out of the following words from the text.

1.	non-living	a.	reasons
2.	ecologically	b.	world
3.	mathematical	c.	lands
4.	human	d.	ignorance
5.	widespread	e.	species
6.	environmental	f.	bad
7.	grazing	g.	systems
8.	subject	h.	parts
9.	population	i.	ecology
10.	human-made	j.	matter
11.	individual	k.	activity

Task 5. Match the words and word combinations with their equivalents in Russian.

1.	interact	a.	поддерживать
2.	sense	b.	десятилетия
3.	decades	c.	включая
4.	distribution	d.	взаимодействовать
5.	improve	e.	цель
6.	levels	f.	чувство
7.	appreciate	g.	улучшать
8.	implications	h.	адаптировать

9.	adapting	i.	подниматься
10.	support	j.	включение
11.	ascends	k.	распределение
12.	including	l.	уровни
13.	goal	m.	ценить

Task 6. Translate the sentences from Russian into English.

1. Экологи заинтересованы в разумном использовании ресурсов природы.
2. Экология популяций является одной из подразделов экологии как науки.
3. Человечество на протяжении многих столетий изменяет окружающую среду – и не всегда в хорошую сторону.
4. Многие современные ученые подчеркивают важность изучения способов сохранения натуральных ресурсов.
5. Будущие профессиональные экологи должны обладать широким кругом знаний из области физики, химии, агрономии, биологии и других наук.
6. Деятельность некоторых промышленных предприятий приносит огромный вред различным видам животных и растений.
7. Ученые по всему миру должны взаимодействовать друг с другом, чтобы достичь главной цели – сохранить окружающую среду.

8. Необходимо, чтобы каждый научился ценить природу.

9. Многие виды животных и растений находятся на грани исчезновения.

Task 7. Insert prepositions where necessary.

1. Ecology is the study____environmental systems.
2. Environment is greatly impacted____human activity.
3. They have been ascending____the mountain for 2 days already.
4. Have a look____this article – it might be very useful for your report.
5. He's interested____studying the endangered species.
6. Next term I'd like to take a course____applied ecology.
7. We'd better appreciate____the surrounding nature as we're part of it.
8. His research is based___the experiments done by him in the laboratory.
9. To be successful in this competition you should focus___the details.
10. People are changing the environment every day___many ways.

Comprehension and discussion

Task 8. Answer the questions.

1. What is ecology?
2. What is the "public" connotation of ecology?
3. What is the subject matter of ecology?
4. What does biogeography/theoretical/applied/empirical/industrial ecology study?
5. Name four main reasons why should we study ecology.
6. What knowledge should future professional ecologists obtain?
7. What is the goal of modern ecologists?

Task 9. Are these statements true or false? Explain your opinion according to the text.

1. "Environmental" usually means relating to the human-made world.
2. Ecology is technically an academic discipline because it is often used to connote some sort of normative or evaluative issue.
3. The subject matter of ecology is the entire natural world, including both the living and the non-living parts.

4. Industrial ecology is a discipline that has been developed long time ago, especially in the USA, where the objective is to follow the energy and material use throughout the process of making an automobile with the objective of attempting to improve the material and energy efficiency of manufacturing.

5. Theoretical ecology attempts to derive or apply theoretical or sometimes mathematical reasons and generalities for what is observed in nature.

6. Empirical ecology is concerned principally with measurement.

7. Ecology and environmentalism can be the same in case of understanding, predicting and adapting to these issues.

8. Ecologists interested in population ecology are encouraged to take courses and undertake readings in agronomy, demography, human geography, sociology, economics, and so on.

Task 10. Match the fields of ecology (1-6) with their appropriate subject matters (a-f).

1. studies the entire natural world, including both the living and the non-living parts.
2. studies the observed distribution of plants and animals and the reasons behind it.
3. is a discipline that has recently been developed, especially in Europe, where the objective is to follow the energy and material use throughout the process of, e.g., making an automobile with the objective of attempting to improve the material and energy efficiency of manufacturing.
4. attempts to derive or apply theoretical or sometimes mathematical reasons and generalities for what is observed in nature.
5. is concerned principally with measurement.
6. studies what is found from one or both of these approaches and uses it to protect or manage nature in some way.

a. Ecology
b. Applied ecology
c. Biogeography
d. Empirical ecology
e. Industrial ecology
f. Theoretical ecology

Task 11. Make up short dialogues using the given words and phrases.

a. Impact, proportion, be interested in, protect
b. Appreciate, species, considerable, predict
c. Alter, encourage, evaluative, take a course
d. Environment, connote, focus, available
e. Goal, issue, concern, ignorance
f. Emphasize, to deal with, apparent, widespread

Task 12. Read the text and insert the missing words from the box. Then translate the text into Russian.

abiotic, interdisciplinary, biomass, coined, organisms, interactions, urban, biotic, focus.

Ecology (from Greek: οἶκος, "house"; -λογία, "study of"[A]) is the scientific analysis and study of 1.________among organisms and their environment. It is an 2._______ field that includes biology and Earth science. Ecology includes the study of interactions organisms have with each other, other organisms, and with abiotic components of their environment. Topics of interest to ecologists include the diversity, distribution, amount (biomass), and number (population) of particular organisms; as well as cooperation and competition between organisms, both within and among ecosystems. Ecosystems are composed of dynamically interacting parts including 3. _______ , the communities they make up, and the non-living components of their environment. Ecosystem processes, such as primary production, pedogenesis, nutrient cycling, and various niche construction activities, regulate the flux of energy and matter through an environment. These processes are sustained by organisms with specific life history traits, and the variety of organisms is called biodiversity. Biodiversity, which refers to the varieties of species, genes, and ecosystems, enhances certain ecosystem services.

Ecology is not synonymous with environment, environmentalism, natural history, or environmental science. It is closely related to evolutionary biology, genetics, and ethology. An important 4._____ for ecologists is to improve the understanding of how biodiversity affects ecological function. Ecologists seek to explain:

- Life processes, interactions and adaptations
- The movement of materials and energy through living communities
- The successional development of ecosystems
- The abundance and distribution of organisms and biodiversity in the con-

text of the environment.

Ecology is a human science as well. There are many practical applications of ecology in conservation biology, wetland management, natural resource management (agroecology, agriculture, forestry, agroforestry, fisheries), city planning (5.______ ecology), community health, economics, basic and applied science, and human social interaction (human ecology). For example, the Circles of Sustainability approach treats ecology as more than the environment 'out there'. It is not treated as separate from humans. Organisms (including humans) and resources compose ecosystems which, in turn, maintain biophysical feedback mechanisms that moderate processes acting on living (6.______) and non-living (7.______) components of the planet. Ecosystems sustain life-supporting functions and produce natural capital like 8._______ production (food, fuel, fiber and medicine), the regulation of climate, global biogeochemical cycles, water filtration, soil formation, erosion control, flood protection and many other natural features of scientific, historical, economic, or intrinsic value.

The word "ecology" ("Ökologie") was 9._______in 1866 by the German scientist Ernst Haeckel (1834–1919). Ecological thought is derivative of established currents in philosophy, particularly from ethics and politics. Ancient Greek philosophers such as Hippocrates and Aristotle laid the foundations of ecology in their studies on natural history. Modern ecology became a much more rigorous science in the late 19th century. Evolutionary concepts relating to adaptation and natural selection became the cornerstones of modern ecological theory.

(Retrieved from: https://en.wikipedia.org/wiki/Ecology)

Glossary

- Maintain – содержать, поддерживать, сохранять
- Rigorous – строгий, точный
- Erosion – эрозия, разрушение
- Cornerstone – краеугольный камень, основа
- Diversity – разнообразие, многообразие
- Foundation – основа, база

Task 13. Write questions to the underlined words in the following sentences.

1. <u>Organisms (including humans) and resources</u> compose ecosystems which, in turn, maintain <u>biophysical feedback</u> mechanisms that <u>moderate processes acting on living (biotic) and non-living (abiotic) components of the planet.</u>
2. <u>Modern ecology</u> became a much more <u>rigorous</u> science <u>in the late 19th</u>

century.

3. Ancient Greek philosophers such as Hippocrates and Aristotle laid the foundations of ecology in their studies on natural history.

4. Ecosystems sustain life-supporting functions and produce natural capital like biomass production (food, fuel, fiber and medicine), the regulation of climate, global biogeochemical cycles, water filtration, soil formation, erosion control, flood protection and many other natural features of scientific, historical, economic, or intrinsic value.

Task 14. Translate from Russian into English.

1. Данный проект основан на тщательном анализе результатов обследования сотни пациентов.
2. Россия – это страна огромного разнообразия видов растений и животных.
3. Экология изучает взаимодействия представителей различных популяций и их влияние друг на друга.
4. Несколько выдающихся ученых заложили основу этой науки еще в средние века.
5. Существует много причин разрушения верхнего слоя почвы, например – дождевые воды.
6. Специалисты по вопросам окружающей среды сосредоточены на изучении многообразия и распределения живых организмов в природе.

Task 15. Put the statements in the right order as they appear in the text.

1. Topics of interest to ecologists include the diversity, distribution, amount (biomass), and number (population) of particular organisms; as well as cooperation and competition between organisms, both within and among ecosystems.
2. Evolutionary concepts relating to adaptation and natural selection became the cornerstones of modern ecological theory.
3. Ecology is not synonymous with environment, environmentalism, natural history, or environmental science.
4. Ecology (from Greek: οἶκος, "house"; -λογία, "study of"[A]) is the scientific analysis and study of interactions among organisms and their environment.
5. There are many practical applications of ecology in conservation biology, wetland management, natural resource management (agroecology, agriculture, forestry, agroforestry, fisheries), city planning (urban ecology), community health,

economics, basic and applied science, and human social interaction (human ecology).

6. Ancient Greek philosophers such as Hippocrates and Aristotle laid the foundations of ecology in their studies on natural history.

7. Ecosystems sustain life-supporting functions and produce natural capital like biomass production (food, fuel, fiber and medicine), the regulation of climate, global biogeochemical cycles, water filtration, soil formation, erosion control, flood protection and many other natural features of scientific, historical, economic, or intrinsic value.

8. Biodiversity, which refers to the varieties of species, genes, and ecosystems, enhances certain ecosystem services.

Task 16. Are these statements true or false? Explain your opinion according to the text.

1. Ecology includes the study of interactions organisms have with each other, other organisms, and with abiotic components of their environment.
2. Ecology is synonymous with environment, environmentalism, natural history, or environmental science.
3. Ecology isn't related to evolutionary biology, genetics, and ethology.
4. Ecology is a human science as well. There are many practical applications of ecology in conservation biology, wetland management, natural resource management (agroecology, agriculture, forestry, agroforestry, fisheries), city planning (urban ecology), community health, economics, basic and applied science, and human social interaction (human ecology).
5. Ancient Roman philosophers such as Hippocrates and Aristotle laid the foundations of ecology in their studies on natural history.
6. Modern ecology became a much more rigorous science in the late 20th century.

Task 17. Translate the article into English and render it.

Экология как наука

Как самостоятельная наука экология сформировалась приблизительно к 1900 г. Термин «экология» был предложен немецким биологом Эрнстом Геккелем в 1869 г. Следовательно, это сравнительно молодая наука. Но именно она переживает в настоящее время период быстрого роста.

Существует много определений экологии, однако подавляющее большинство современных исследователей считает, что экология — это наука, изучающая условия существования живых организмов и взаимосвязи между организмами и средой, в которой они обитают.

Понятие экологии очень обширно, поэтому в зависимости от акцента на той или иной ее задаче меняется и формулировка определения. Для «долгосрочного употребления» лучшим может быть, например, следующее: «Экология — это биология окружающей среды». Для последних десятилетий XX в. наиболее подходит одно из определений экологии, приведенное в полном словаре Уэбстера: «Предмет экологии — это совокупность или структура связей между организмами и средой». Эрнст Геккель дал этой науке исчерпывающее определение: «Под экологией мы понимаем сумму знаний, относящихся к экономике природы: изучение всей совокупности взаимоотношений животного с окружающей его средой, как органической, так и неорганической, и прежде всего — его дружественных или враждебных отношений с теми животными и растениями, с которыми оно прямо или косвенно вступает в контакт. Одним словом экология — это изучение всех сложных взаимоотношений, которые Дарвин назвал условиями, порождающими борьбу за существование».

Экология, как и всякая другая наука, имеет два аспекта:

первый — это стремление к познанию ради самого познания,

второй — применение собранных знаний для решения практических проблем, связанных с окружающей средой.

Все возрастающее значение экологии объясняется тем, что ни один из вопросов огромной практической важности в настоящее время нельзя решить без учета связей между живыми и неживыми компонентами природы.

Практический выход экологии можно видеть, прежде всего, в решении вопросов природопользования; именно она должна создать научную основу эксплуатации природных ресурсов. Законы, лежащие в основе естественных природных процессов, будут в центре нашего внимания. Однако прежде необходимо остановиться на взаимоотношении экологии и охраны природы. Западные ученые обычно различают науку экологию и науки об окружающей среде. Экология изучает три группы факторов среды, воздействующих на организмы:

абиотические

биотические

антропогенные.

Охрана природы рассматривает только третий фактор — воздействие человека на среду, и то не во всем совпадает с общеэкологическим подходом. Охрана природы и шире и уже раздела экологии, который исследует влияние антропогенного фактора на природу. Уже — потому, что анализируется не любое воздействие, а лишь то, последствие которого может иметь значение для жизни человеческого общества. Шире — потому, что рассматривается влияние антропогенного фактора не только на органический мир, но и на неживую природу.

UNIT 2. ENVIRONMENT

2.1 NATURAL ENVIRONMENT

PRE-READING

Task 1. Read the words correctly, mind the stress.

environment, concept, massive, vegetation, microorganisms, atmosphere, phenomena, universal, magnetism, radiation, impact, lithosphere, hydrosphere, atmosphere, biosphere, cryosphere, pedosphere.

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What is environment?
2. What are its main components?
3. Why is it important to preserve environment?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

Environment

The natural environment, commonly referred to simply as the environment, is a term that encompasses all living and non-living things occurring naturally on Earth or some region thereof.

The concept of the natural environment can be distinguished by components:

Complete ecological units that function as natural systems without massive human intervention, including all vegetation, animals, microorganisms, soil, rocks, atmosphere and natural phenomena that occur within their boundaries.

Universal natural resources and physical phenomena that lack clear-cut boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, not originating from human activity.

The natural environment is contrasted with the built environment, which comprises the areas and components that are strongly influenced by humans. A geographical area is regarded as a natural environment (with an indefinite article), if the human impact on it is kept under a certain limited level.

Composition

Earth science generally recognizes 4 spheres, the lithosphere, the hydrosphere, the atmosphere, and the biosphere as correspondent to rocks, water, air, and life. Some scientists include, as part of the spheres of the Earth, the cryosphere (corresponding to ice) as a distinct portion of the hydrosphere, as well as the pedosphere (corresponding to soil) as an active and intermixed sphere. Earth science (also known as geoscience, the geosciences or the Earth Sciences), is an all-embracing term for the sciences related to the planet Earth. There are four major disciplines in earth sciences, namely geography, geology, geophysics and geodesy. These major disciplines use physics, chemistry, biology, chronology and mathematics to build a qualitative and quantitative understanding of the principal areas or spheres of the Earth system.

Geological activity

The Earth's crust, or Continental crust, is the outermost solid land surface of the planet, is chemically and mechanically different from underlying mantles, and has been generated largely by igneous processes in which magma (molten rock) cools and solidifies to form solid land. Plate tectonics, mountain ranges, volcanoes, and earthquakes are geological phenomena that can be explained in terms of energy transformations in the Earth's crust, and might be thought of as the process by which the earth resurfaces itself. Beneath the Earth's crust lies the mantle which is heated by the radioactive decay of heavy elements. The mantle is not quite solid and consists of magma which is in a state of semi-perpetual convection. This convection process causes the lithospheric plates to move, albeit slowly. The resulting process is known as plate tectonics. Volcanoes result primarily from the melting of subducted crust material. Crust material that is forced into the Asthenosphere melts, and some portion of the melted material becomes light enough to rise to the surface, giving birth to volcanoes!

Oceanic activity

An ocean is a major body of saline water, and a component of the hydrosphere. Approximately 71% of the Earth's surface (an area of some 361 million square kilometers) is covered by ocean, a continuous body of water that is customarily divided into several principal oceans and smaller seas. More than half of this area is over 3,000 meters (9,800 ft) deep. Average oceanic salinity is around 35 parts per thousand (ppt) (3.5%), and nearly all seawater has a salinity in the range of 30 to 38 ppt. Though generally recognized as several 'separate' oceans, these waters comprise one global, interconnected body of salt water often referred to as the World Ocean or global ocean. This concept of a global ocean as a continuous body of water with relatively free interchange among its parts is of fundamental importance to oceanography.

The major oceanic divisions are defined in part by the continents, various archipelagos, and other criteria: these divisions are (in descending order of size) the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, the Southern Ocean (which is sometimes subsumed as the southern portions of the Pacific, Atlantic, and Indian Oceans), and the Arctic Ocean (which is sometimes considered a sea of the Atlantic). The Pacific and Atlantic may be further subdivided by the equator into northerly and southerly portions. Smaller regions of the oceans are called seas, gulfs, bays and other names. There are also salt lakes, which are smaller bodies of landlocked saltwater that are not interconnected with the World Ocean. Two notable examples of salt lakes are the Aral Sea and the Great Salt Lake.

Atmosphere, climate and weather

The atmosphere of the Earth serves as a key factor in sustaining the planetary ecosystem. The thin layer of gases that envelops the Earth is held in place by the planet's gravity. Dry air consists of 78% nitrogen, 21% oxygen, 1% argon and other inert gases, carbon dioxide, etc.; but air also contains a variable amount of water vapor. The atmospheric pressure declines steadily with altitude, and has a scale height of about 8 kilometres at the Earth's surface: the height at which the atmospheric pressure has declined by a factor of e (a mathematical constant equal to 2.71...).The ozone layer of the Earth's atmosphere plays an important role in depleting the amount of ultraviolet (UV) radiation that reaches the surface. As DNA is readily damaged by UV light, this serves to protect life at the surface. The atmosphere also retains heat during the night, thereby reducing the daily temperature extremes.

Life

Although there is no universal agreement on the definition of life, scientists generally accept that the biological manifestation of life is characterized by organization, metabolism, growth, adaptation, response to stimuli and reproduction. Life may also be said to be simply the characteristic state of organisms.

Properties common to terrestrial organisms (plants, animals, fungi, protists, archaea and bacteria) are that they are cellular, carbon-and-water-based with complex organization, having a metabolism, a capacity to grow, respond to stimuli, and reproduce. An entity with these properties is generally considered life. However, not every definition of life considers all of these properties to be essential. Human-made analogs of life may also be considered to be life.

The biosphere is the part of Earth's outer shell — including air, land, surface rocks and water — within which life occurs, and which biotic processes in turn alter or transform. From the broadest geophysiological point of view, the biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere (rocks), hydrosphere (water), and atmosphere (air). Currently the entire Earth contains over 75 billion tons (150 trillion pounds or about 6.8 x 1013 kilograms) of biomass (life), which lives within various environments within the biosphere.

(Retrieved from: https://en.wikipedia.org/wiki/Natural_environment)

Vocabulary

- Concept [ˈkɒnsept] – понятие, идея, концепция
- Intervention [ˌɪntəˈvenʃn] – вмешательство
- Boundary [ˈbaʊndri] – граница, предел
- Envelope [ˈenvələʊp] – окружать, обернуть
- Deplete [dɪˈpliːt]– истощать, опустошать, исчерпывать
- Manifestation [ˌmænɪfeˈsteɪʃn] – проявление, демонстрация
- Cellular [ˈseljələ(r)] – клеточный, состоящий из клеток

Word study

Task 4. Match the words with their appropriate meanings.

1. concept	a. кора
2. vegetation	b. поверхность
3. comprise	c. залив, бухта
4. surface	d. понятие, идея
5. igneous	e. воспроизведение, размножение
6. decay	f. содержать, включать в себя
7. crust	g. растительность
8. gulf	h. взаимодействие
9. reproduction	i. гнить, разлагаться, разрушаться
10. interaction	j. вулканический, огненный

Task 5. Give the English equivalents.

1. окружающая среда
2. почва
3. феномен
4. влияние, воздействие
5. количественный
6. качественный
7. твердый, плотный
8. мантия
9. хотя, тем не менее
10. соленость
11. сила тяжести, тяжесть
12. атмосферное давление
13. истощать, исчерпывать
14. оболочка

Task 6. Divide the following words into the groups: “lithosphere”, “hydrosphere”, “atmosphere”, “biosphere”.

adaptation	magma	rock
atmospheric	metabolism	salinity
bays	nitrogen	seawater
crust	oceanography	tectonics
earthquakes	organization	vapor
gases	oxygen	volcanoes
gulfs	pressure	
land surface	reproduction	

Comprehension and discussion

Task 7. Answer the questions.

1. How can the concept of the “natural environment” be distinguished?

2. What is the "built environment"?
3. Name 4 main spheres of the environment?
4. What is the cryosphere and the pedosphere?
5. What are the main disciplines in earth sciences?
6. What causes lithospheric plates to move?
7. How are the volcanoes formed?
8. How much of the Earth's surface is covered by ocean?
9. Name the oceans and the most well-known salt lakes.
10. What chemical elements does the air consist of?
11. Why is the ozone layer so important for our planet?
12. What are the properties of the terrestrial organisms?
13. What is the biosphere and what does it include?

Task 8. Speak on the given topic using the following words and word combinations.

1. Lithosphere: crust, solid, magma, mantles, plate tectonics, mountain ranges, volcanoes, and earthquakes, surface, lithospheric plates
2. Hydrosphere: saline water, salinity, oceanography, seas, gulfs, bays, lakes, global ocean
3. Atmosphere: gases, carbon dioxide, vapor, atmospheric pressure, ultraviolet (UV) radiation, ozone layer
4. Biosphere: organization, metabolism, growth, adaptation, reproduction, cellular, biotic processes

Task 9. Read and translate the article from Russian into English.

Окружáющая средá — обобщённое понятие, характеризующее природные условия некоторой местности и её экологическое состояние. Окружающая среда обычно рассматривается как часть среды, которая взаимодействует с данным живым организмом (человеком, животным и т. д.), включая объекты живой и неживой природы.

Словосочетание *окружающая среда*, как правило, применяется к описанию природных условий на поверхности Земли, состоянию её локальных и глобальных экосистем и их взаимодействию с человеком. В таком значении термин используется в международных соглашениях.

В современную эпоху человеческая деятельность охватила практически всю географическую оболочку, и её масштабы теперь сравнимы с действием глобальных природных процессов, что негативно сказывается на состоянии окружающей среды. Окружающая среда — это среда обитания и деятельности человечества, весь окружающий человека мир, включая и природную, и антропогенную среду.

В рамках ООН создана специальная организация — Программа ООН по окружающей среде (англ. *UNEP*). В целях привлечения внимания к проблемам охраны окружающей среды ООН установила Всемирный день окружающей среды.

В Российской Федерации законодательное определение понятия «благоприятная окружающая среда» дано в статье 1 Федерального закона № 7-ФЗ «Об охране окружающей среды» от 10 января2002 года:

Благоприятная окружающая среда — окружающая среда, качество которой обеспечивает устойчивое функционирование естественных экологических систем, природных и природно-антропогенных объектов.

Нормативы в области охраны окружающей среды (далее также — природоохранные нормативы) — установленные нормативы качества окружающей среды и нормативы допустимого воздействия на неё, при соблюдении которых обеспечивается устойчивое функционирование естественных экологических систем и сохраняется биологическое разнообразие.

Таким образом, право на благоприятную окружающую среду обеспечивается системой природоохранных нормативов, а критерием соблюдения этого права является соответствие качества окружающей среды и воздействий на неё соответствующим природоохранным нормативам.

(Retrieved from: https://ru.wikipedia.org/wiki/Окружающая_среда)

Task 10. Choose one of the topics to make a report and present it in front of the class.

- What is environment?
- The main problems of the environment.
- Means to preserve the environment.

2.2 BIODIVERSITY

PRE-READING

Task 1. Read the words correctly, mind the stress.

Insects, biodiversity, fungi, algae, deserts, province, diverse, endemic, coral, reefs, genetic, resistant, diseases, fertilize, ecosystems, oxygen, fiber, industries, pharmaceutical, hospitality, enormous, aspirin, extinct.

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What is biodiversity?
2. How many species of animals exist on the Earth?
3. Why is biodiversity so important for some industries?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

Biodiversity

Species by the Numbers

Scientists have identified about 1.75 million different species. That includes 950,000 species of insects, 270,000 species of plants, 19,000 species of fish, 9,000 species of birds, and 4,000 species of mammals. This is only a small portion of the total number of species on Earth. There are millions more species yet to be discovered and named.

Biodiversity refers to all the different kinds of living organisms within a given area. Biodiversity includes plants, animals, fungi, and other living things. Biodiversity can include everything from towering redwood trees to tiny, single-cell algae that are impossible to see without a microscope. Kinds of Biodiversity

A common way to measure biodiversity is to count the total number of species living within a particular area. Tropical regions, areas that are warm year-round, have the most biodiversity. Temperate regions, which have warm summers and cold winters, have less biodiversity. Regions with cold or dry conditions, such as mountaintops and deserts, have even less. Generally, the closer a region is to the Equator, the greater the biodiversity. At least 40,000 different plant species live in the Amazon rain forest of South America, one of the most biologically diverse regions on the planet. Only about 2,800 live in Canada's Quebec province. The warm waters of the western Pacific and Indian Oceans tend to be the most diverse marine environments. The Bird's Head Seascape in Indonesia is home to more than 1,200 species of fish and 600 species of coral. Many of the corals build coral reefs, which are home to hundreds more species, from tiny seaweeds to large sharks. Some places in the world have a large number of endemic species—species that exist only in that place. The Cape Floristic Region in South Africa is home to about 6,200 plant species found nowhere else in the world. Areas with high numbers of endemic species are called biodiversity hotspots. Scientists and communities are making a special effort to preserve biodiversity in these regions. Biodiversity can also refer to the variety of ecosystems—communities of living things and their environments. Ecosystems include deserts, grasslands, and rain forests. The continent of Africa is home to tropical rain forests, alpine mountains, and dry deserts. It enjoys a high level of biodiversity. Antarctica, covered almost entirely by an ice sheet, has low biodiversity. Another way to measure biodiversity is genetic diversity. Genes are the basic units of biological information passed on when living things reproduce. Some species have as many as 400,000 genes. (Human beings have about 25,000 genes, while rice has more than 56,000.) Some of these genes are the same for all individuals within a species—they're what make a daisy a daisy and a dog a dog. But some genes within a species are different. This genetic variation is why some dogs are poodles and some are pit bulls. It's why some people have brown eyes and some people have blue eyes. Greater genetic diversity in species can make plants and animals more resistant to diseases. Genetic diversity also allows species to better adapt to a changing environment.

Importance of Biodiversity

All species are interconnected. They depend on one another. Forests provide homes for animals. Animals eat plants. The plants need healthy soil to grow. Fungi help decompose organisms to fertilize the soil. Bees and other insects carry pollen from one plant to another, which enables the plants to reproduce. With less biodiversity, these connections weaken and sometimes break, harming all the species in the ecosystem.

Ecosystems with a lot of biodiversity are generally stronger and more resistant to disaster than those with fewer species. For instance, some diseases kill only one kind of tree. In the early 1900s, American chestnut blight killed most of the chestnut trees in the eastern forests of North America. The forest ecosystem survived because other kinds of trees also grew there. Biodiversity is important to people in many ways. Plants, for instance, help humans by giving off oxygen. They also provide food, shade, construction material, medicines, and fiber for clothing and paper. The root system of plants helps prevent flooding. Plants, fungi, and animals such as worms keep soil fertile and water clean. As biodiversity decreases, these systems break down. Hundreds of industries rely on plant biodiversity. Agriculture, construction, medical and pharmaceutical, fashion, tourism, and hospitality all depend on plants for their success. When the biodiversity of an ecosystem is interrupted or destroyed, the economic impact on the local community could be enormous. Biodiversity is especially important to the medical and pharmaceutical industries. Scientists have discovered many chemicals in rain forest plants that are now used in helpful drugs. One of the most popular and safe pain relievers, aspirin, was originally made from the bark of willow trees. Medicines that treat some forms of cancer have been made from the rosy periwinkle, a flower that grows on the African island of Madagascar. Scientists have studied only a small percentage of rain forest species in their search for cures. But every year, thousands of species go extinct, or die out entirely, before scientists can determine whether they might be useful in medicines.

(Retrieved from: http://education.nationalgeographic.com/encyclopedia/biodiversity/)

Vocabulary

- Fungi [ˈfʌŋgiː], [ˈfʌŋgaɪ], [ˈfʌndʒaɪ] – гриб
- Grassland [ˈgrɑːslænd] – пастбище, луг
- Pollen [ˈpɒlən] – пыльца
- Fiber [ˈfaɪbə(r)] – волокно
- Extinct [ɪkˈstɪŋkt] – вымерший
- Drug [drʌg] – лекарство
- Pain reliever [peɪn rɪˈliːvə(r)] – болеутоляющее средство

Word study

Task 4. Find the English equivalents in the text.

1. вид
2. млекопитающие
3. определенная местность
4. умеренные регионы
5. экватор
6. разнообразный
7. коралловые рифы
8. тропический лес, джунгли
9. альпийские горы
10. ген
11. удобрять
12. пыльца, опылять
13. устойчивый
14. например
15. корневая система

Task 5. Use your dictionary to complete the table.

Verb	Noun	Adjective
include		
discover		
		living
measure		
		diverse
	effort	
adapt		
	variation	
exist		

Task 6. Pair the equivalents in meaning.

portion	small
discover	live
tiny	join, bind
environment	attempt
exist	stable, steady
effort	support, ensure, guarantee
interconnect	part, share
provide	medicine
resistant	surroundings
drug	find, reveal, open

Task 7. Make up sentences. Mind the word order.

1. identified/ scientists/ have/ different/ about 1.75 million/ species.
2. biodiversity/ within/ the/ given/ kinds/ living/ to/ organisms/ a/ all/ different/ of/ area/ refers.
3. equator/ the/ closer/ is/ the/ generally/ the/ region/ greater/ to/ the/ a/ biodiversity.
4. a/ and/ communities/ these/ are/ effort/ to/ making/ biodiversity/ special/ in/ scientists/ preserve/ regions.
5. another/ genetic/ to/ biodiversity/ way/ is/ diversity/ measure.
6. 400,000/ some/ have/ genes/ species/ as many as.

7. genetic/ some/ why/ variation/ poodles/ is/ some/ are/ this/ and/ are/ dogs/ pit bulls.

8. ecosystems/ with/ biodiversity/ are/ disaster/ fewer/ generally/ with/ and/ more resistant/ those/ to/ a lot of/ than/ stronger/ species.

9. is/ and/ especially/ medical/ biodiversity/ pharmaceutical/ important/ industries/ the/ to.

Comprehension and discussion

Task 8. Decide if these statements are true or false. Explain your opinion according to the text.

1. Biodiversity includes plants, animals, fungi, and other living things.
2. Temperate regions, which have warm summers and cold winters, have more biodiversity.
3. Generally, the closer a region is to the Equator, the lower the biodiversity.
4. Human beings have about 15,000 genes.
5. Greater genetic diversity in species can make plants and animals more resistant to diseases.
6. Ecosystems with a lot of biodiversity are generally weaker and less resistant to disaster than those with fewer species.
7. One of the most popular and safe pain relievers, aspirin, was originally made from the bark of chestnut trees.

Task 9. Discuss the following problems with your partner using the word combinations from the text.

- What is biodiversity?
- Kinds of biodiversity
- Importance of biodiversity

Task 10. Read the text and insert the missing words from the box. Then translate the text into Russian.

Decreasing Biodiversity

factor, increases , decreased, danger, declines, multiplied, preserve, extinction.

In the past hundred years, biodiversity around the world has 1_______dramatically. Many species have gone extinct. 2________is a natural process; some species naturally die out while new species evolve. But human activity has changed the natural processes of extinction and evolution. Scientists estimate that species are dying out at hundreds of times the natural rate. A major reason for the loss of biodiversity is that natural habitats are being destroyed. The fields, forests, and wetlands where wild plants and animals live are disappearing. Land is cleared to plant crops or build houses and factories. Forests are cut for lumber and firewood. Between 1990 and 2005, the amount of forested land in Honduras, for instance, dropped 37 percent. As habitats shrink, fewer individuals can live there. The creatures that survive have fewer breeding partners, so genetic diversity 3_______. Pollution, overfishing, and overhunting have also caused a drop in biodiversity. Global climate change—the latest rise in the average temperature around the globe, linked to human activity—is also a 4_______. Warmer ocean temperatures damage fragile ecosystems such as coral reefs. A single coral reef can shelter 3,000 species of fish and other sea creatures such as clams and sea stars.

Biodiversity can also be harmed by introduced species. When people introduce species from one part of the world to another, they often have no natural predators. These non-native species thrive in their new habitat, often destroying native species in the process. Brown tree snakes, for instance, were accidentally brought into Guam, an island in the South Pacific, in the 1950s. Because brown tree snakes have no predators on Guam, they quickly 5______. The snakes, which hunt birds, have caused the extinction of nine of the island's 11 native forest-dwelling bird species. People all over the world are working to maintain the planet's biodiversity. In the United States, the Endangered Species Act protects about 2,000 organisms that are in 6________of becoming extinct. Animals and plants are the most familiar types of endangered species, but a fungus, such as the white ferula mushroom can also be threatened. The white ferula mushroom, a delicacy that only grows on the Italian island of Sicily, helps decompose organic compounds such as plants. Some environmental groups are working to create a sustainable mushroom population to satisfy consumers as well as the local ecosystem. Around the globe, thousands of wilderness areas have been set up to conserve plants, animals, and ecosystems. Local, national, and international organizations are cooperating to 7_______the biodiversity of regions threatened by development or natural disasters. UNESCO's World Heritage Site program recognizes areas of global importance, such as the enormous wetland region of the Pantanal in South America. Many national parks, such as Glacier National Park in the U.S. state of Montana, protect biodiversity within the park by restricting extractive activities, such as mining and drilling. Marine protected areas (MPAs) have been established to preserve sea life. In the marine protected area around Australia's Great Barrier Reef, no-fishing zones have helped fish populations thrive. People are also working to limit pollution and restore coral reef ecosystems in the area. As ecosystems become healthier, their biodiversity 8_______.

2.3 ECOLOGICAL NICHE

PRE-READING

Task 1. Read and translate and give the transcription of the names of the animals. Consult your dictionary if necessary.

- thrasher
- shrew
- tawny owl
- kestrel
- carnivore
- herbivore
- beaver
- lizard
- tarpan
- konik

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What is ecological niche?
2. What does it consist of?
3. Who was the founder of the term 'ecological niche'?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

Ecological niche

In ecology, a niche is a term with a variety of meanings related to the behavior of a species living under specific environmental conditions. The ecological niche describes how an organism or population responds to the distribution of resources and competitors (for example, by growing when resources are abundant, and when predators, parasites and pathogens are scarce) and how it in turn alters those same factors (for example, limiting access to resources by other organisms, acting as a food source for predators and a consumer of prey).

The notion of ecological niche is central to ecological biogeography, which focuses on spatial patterns of ecological communities. Species distributions and their dynamics over time result from properties of the species, environmental variation, and interactions between the two — in particular the abilities of some species, especially our own, to modify their environments and alter the range dynamics of many other species. Alteration of an ecological niche by its inhabitants is the topic of niche construction.

The majority of species exist in a standard ecological niche, but there are exceptions. A premier example of a non-standard niche filling species is the flightless, ground-dwelling kiwi bird of New Zealand, which feeds on worms and other ground creatures, and lives its life in a mammal niche. Island biogeography can help explain island species and associated unfilled niches.

Grinnellian niche

The ecological meaning of niche comes from the meaning of niche as a recess in a wall for a statue, which itself is probably derived from the Middle French word *nicher*, meaning *to nest*. The term was coined by the naturalist Roswell Hill Johnson, but Joseph Grinnell was probably the first to use it in a research program in 1917, in his paper "The niche relationships of the California Thrasher".

The Grinnellian niche concept embodies the idea that the niche of a species is determined by the habitat in which it lives and its accompanying behavioral adaptations. In other words, the niche is the sum of the habitat requirements and behaviors that allow a species to persist and produce offspring. For example, the behavior of the California Thrasher is consistent with the chaparral habitat it lives in—it breeds and feeds in the underbrush and escapes from its predators by shuffling from underbrush to underbrush. Its 'niche' is defined by the felicitous complementing of the thrasher's behavior and physical traits (camouflaging color, short wings, strong legs) with this habitat.

This perspective of niche allows for the existence of both ecological equivalents and empty niches. An ecological equivalent to an organism is an organism from a different taxonomic group exhibiting similar adaptations in a similar habitat, an example being the different succulents found in American and African deserts, cactus and euphorbia. As another example, the *Anolis* lizards of the Greater Antilles are a rare example of convergent evolution, adaptive radiation, and the existence of ecological equivalents: the *Anolis* lizards evolved in similar microhabitats independently of each other and resulted in the same ecomorphs across all four islands.

Eltonian niche

In 1927 Charles Sutherland Elton, a British ecologist, defined a niche as follows: "The 'niche' of an animal means its place in the biotic environment, *its relations to food and enemies*."

Elton classified niches according to foraging activities ("food habits"): "For instance there is the niche that is filled by birds of prey which eat small animals such as shrews and mice. In an oak wood this niche is filled by tawny owls, while in the open grassland it is occupied by kestrels. The existence of this carnivore niche is dependent on the further fact that mice form a definite herbivore niche in many different associations, although the actual species of mice may be quite different."

Conceptually, the Eltonian niche introduces the idea of a species' *response to* and *effect on* the environment. Unlike other niche concepts the Eltonian niche emphasizes that a species not only grows in and responds to an environment based on available resources, predators, and climatic conditions, a species may also change the availability and behavior of those factors as it grows. In an extreme example, beavers require certain resources in order to survive and reproduce, but also construct dams that alter water flow in the river where the beaver lives. Thus, the beaver affects the biotic and abiotic conditions of other species that live in and near the watershed. In a more subtle case, competitors that consume resources at different rates can lead to cycles in resource density that differ between species. Not only do species grow differently with respect to resource density, their own population growth can lead to different effects on resource density over time.

Hutchinsonian niche

The niche concept was popularized by the zoologist G. Evelyn Hutchinson in 1957. Hutchinson wanted to know why there are so many types of organisms in any one habitat. His work inspired many others to develop models to explain how many and how similar coexisting species could be within a given community, and led to the concepts of 'niche breadth' (the variety of resources or habitats used by a given species), 'niche partitioning' (resource differentiation by coexisting species), and 'niche overlap' (overlap of resource use by different species).

An organism free of interference from other species could use the full range of conditions (biotic and abiotic) and resources in which it could survive and reproduce which is called its fundamental niche. However, as a result of pressure from, and interactions with, other organisms (i.e. inter-specific competition) species are usually forced to occupy a niche that is narrower than this, and to which they are mostly highly adapted. This is termed the realized niche. Hutchinson used the idea of competition for resources as the primary mechanism driving ecology, but overemphasis upon this focus has proved to be a handicap for the niche concept. In particular, overemphasis upon a species' dependence upon resources has led to too little emphasis upon the effects of organisms on their environment, for instance, colonization and invasions.

Hutchinson's "niche" (a description of the ecological space occupied by a species) is subtly different from the "niche" as defined by Grinnell (an ecological role, that may or may not be actually filled by a species).

A niche is a very specific segment of ecospace occupied by a single species. On the presumption that no two species are identical in all respects (called Hardin's 'axiom of inequality') and the competitive exclusion principle, *some* resource or adaptive dimension will provide a niche specific to each species. Species can however share a 'mode of life' or 'autecological strategy' which are broader definitions of ecospace. For example, Australian grasslands species, though different from those of the Great Plains grasslands, exhibit similar modes of life.

Once a niche is left vacant, other organisms can fill that position. For example, the niche that was left vacant by the extinction of the tarpan has been filled by other animals (in particular a small horse breed, the konik). Also, when plants and animals are introduced into a new environment, they have the potential to occupy or invade the niche or niches of native organisms, often outcompeting the indigenous species. Introduction of non-indigenous species to non-native habitats by humans often results in biological pollution by the exotic or invasive species.

The mathematical representation of a species' fundamental niche in ecological space, and its subsequent projection back into geographic space, is the domain of niche modelling.

(Retrieved from: https://en.wikipedia.org/wiki/Ecological_niche)

Vocabulary

- Predator [ˈpredətə(r)] – хищник
- Competitor [kəmˈpetɪtə(r)] – конкурент, соперник, противник

- Distribution [ˌdɪstrɪˈbjuːʃn] – распределение, распространение
- Prey [preɪ] – жертва, добыча
- Offspring [ˈɒfsprɪŋ] – потомство
- Indigenous [ɪnˈdɪdʒənəs] – врожденный, природный, коренной

Word study

Task 4. Give the Russian equivalents.

1. predator
2. competitor
3. modify
4. mammal
5. creature
6. requirement
7. camouflaging
8. habitat
9. offspring
10. emphasize
11. consume
12. affect
13. invasion
14. occupy
15. exhibit

Task 5. Give antonyms to the following words.

1. introduction
2. invade
3. extinction
4. vacant
5. broad
6. proved
7. coexisting
8. availability
9. differ
10. growth
11. standard

Comprehension and discussion

Task 6. Answer the questions.

1. Give the definition of the ecological niche.
2. What is the topic of niche construction?
3. Where does the word “niche” come from?
4. Who and where used the term “niche” for the first time?
5. Describe the Grinnellian niche concept.
6. What is an ecological equivalent?
7. What was Charles Sutherland Elton’s concept of the niche?
8. What characteristics did Charles Sutherland Elton use to classify niches?
9. What was G. Evelyn Hutchinson’s view on the problem?

Task 7. Write all possible questions to the following sentences.

1. The notion of ecological niche is central to ecological biogeography.
2. An ecological equivalent to an organism is an organism from a different taxonomic group exhibiting similar adaptations in a similar habitat.
3. The niche concept was popularized by the zoologist G. Evelyn Hutchinson in 1957.
4. A niche is a very specific segment of ecospace occupied by a single species.

Task 8. Give the definitions of:

1. The ecological niche
2. The Grinnellian niche concept
3. An ecological equivalent to an organism
4. Eltonian’s “niche”
5. Niche breadth
6. Niche partitioning
7. Niche overlap
8. Hutchinson's "niche"
9. Grinnell’s “niche”

Task 9. Find the examples of the passive voice in the text and rewrite the following sentences in passive.

1. Animals occupied the vacant niche in a few days.
2. Scientists inspired their colleagues to go on with their research.

3. Hutchinson popularized his own view on the ecological niche.
4. They grow these plants without using pesticides.
5. Elton introduced his new idea of the niche concept.

Task 10. There are some sentences missing in the text (A-E) – put them in the right places (1-5).

A. This resulted in the acceleration of environmental, behavioral and genetic modifications.

B. The fact that a large number of cultural processes are learned rather than genetically encoded into the individual, makes human culture an incredibly powerful method of niche construction.

C. This back-and-forth creates a feedback relationship between natural selection and niche-construction: when organisms affect their environment, that change can then cause a shift in what traits are being naturally selected for.

D. Cultural diversity is believed to reflect variation in the environments that different populations of humans evolved in, and nothing else.

E. In other words, cultural change has the capacity to codirect its population's genetic evolution.

Niche construction

Niche construction is the process in which an organism alters its own (or other species') environment, often but not always in a manner that increases its chances of survival. Changes that organisms bring about in their worlds that are of no evolutionary or ecological consequence are not examples of niche construction. Several biologists have argued that niche construction is as important to evolution as natural selection(i.e., not only does an environment cause changes in species through selection, but species also cause changes in their environment through niche construction).1_The effect of niche construction is especially pronounced in situations where environmental alterations persist for several generations, introducing the evolutionary role of ecological inheritance. Less drastic niche-constructing behaviors are also quite possible for an organism. This theory, in conjunction with natural selection, shows that organisms inherit two legacies from their ancestors: genes and a modified environment. Together, these two evolutionary mechanisms determine a population's fitness and what adaptations those organisms develop in the continuation for their survival.

Implications

Niche construction has many implications for the human sciences, more specifically human sociobiology, evolutionary psychology, and human behavioral ecology. Standard evolutionary theory only allows for cultural processes to affect genetic evolution by influencing the individual, and depends on the ability of that individual to survive and pass on its genes to the next generation. Cultural processes are viewed merely as an aspect of the human phenotype and are not believed to be consequential to human evolution. 2____This theory overlooks the fact that humans can modify their selective environments through cultural activity, thus feeding back to affect selection. "Cultural processes add a second knowledge inheritance system to the evolutionary process through which socially learned information is accrued, stored, and transmitted between individuals both within and between generations."

With the addition of language to the human culture came an increased mental capacity. This allowed for human adaptation of the environment to be a learned process, unlike nonhuman species, whose adaptive process is instinctual. 3 As niche construction advocate Derek Bickerton writes, "We could construct our niches without having to wait on interminable rounds of feedback between genes and behavior."

A theory on gene-culture coevolution calls for a more integrated relationship between genetic evolution and cultural processes than standard evolutionary theory. In this model, cultural activities are believed to affect the evolutionary process by modifying selection pressures. 4____ Mathematical and conceptual models including investigations of language, handedness, the emergence of incest taboos, the co-evolution of hereditary deafness and sign language, and sexual selection with a culturally transmitted mating preference demonstrate this theory. However, this theory is still dependent on standard evolutionary theory because it requires that cultural processes only affect genes directly, not allowing for any intermediate factors in the environment to interact with these processes at an evolutionary level. This theory exists on a dual inheritance system consisting solely of genes and cultural activity. "The dual inheritance system is a way to include interactions between nature and nurture in a tractable system." In most cases this theory works smoothly, however there are instances where cultural activities create changes in the abiotic environment that then affect selection pressures.

The speed at which humans are able to construct niches modifies the selection pressures and either genetic evolution or further niche construction can result. An example of genetic evolution through niche construction with the inclusion of an abiotic factor: Yam cultivators in West Africa cut clearings in forests to grow crops, but resulted in much standing water which attracted mosquitoes and increased the rate of malaria. This caused a modification to the selection pressure for the sickle-cell allele that protects against malaria. Evolutionary change is thus furthered. Example of further niche construction: Humans change the environment through pollution. The effects of pollution are alleviated by the innovation and use of a new technology. This cultural response to a constructed niche allows for a change in environment and a lack of change in genetics. Only if a new technology is not created or effective will evolutionary change occur. Humans are able to sustain adaptiveness by responding to ancestral niche construction through further cultural niche construction.

The addition of niche construction to the study of evolutionary processes forces scientists to accept that cultural activity is not the reason that humans are able to modify their environments, but is simply their primary means of doing the same thing that other species do. 5_____ "Most of the time, cultural processes can be regarded as a shortcut to acquiring adaptive information, as individuals rapidly learn, or are shown, what to eat, where to live, or how to avoid danger by doing what other more knowledgeable individuals do."

Task 11. Write out the keywords to help you to make a plan of the text. Then retell the text in English briefly.

Task 12. Insert articles where necessary

Consequences

As 1.__ creatures move into new niches, they can have 2.__ significant effect on 3. world around them. 4. first consequence that arises from niche construction is that the organisms have changed 5. environment on which they live.
6.___ good example of this is the leafcutter ants mentioned above. Leafcutter colonies can grow to massive sizes and contain millions of 7.____ individuals. Such 8. large amount of ants require a large food supply. In order to obtain this, 9._ ants need to stockpile a large amount of foliage clippings to feed their crop of fungi. This can devastate surrounding plant life, especially young saplings that need to obtain all the sunlight they can in the rainforests.

Another important consequence is that they can affect natural selection pressures put on a species. The common cuckoo bird is an excellent example of such 10.___ consequence. This species of bird parasitizes other birds by laying their eggs in the other species' nests. This had led to several adaptations among 11._ cuckoos, one of which is a short incubation time for their eggs. The eggs need to hatch first so that the chick can push the other species' eggs out of the nest, ensuring it has no 12.___ competition for the parents' attention. Another adaptation it has acquired is that the chick mimics the calls of multiple young chicks, so that the parents are bringing in food not just for 13.___one offspring, but a whole brood.

(Retrieved from: https://en.wikipedia.org/wiki/Niche_construction)

Task 13. Render the text in English.

Суть принципа конкурентного исключения, также известного как принцип Гаузе, состоит в том, что каждый вид имеет свою собственную экологическую нишу. Никакие два разных вида не могут занять одну и ту же экологическую нишу. Сформулированный таким образом принцип Гаузе подвергался критике. Например, одним из известных противоречий этому принципу является «планктонный парадокс». Все виды живых организмов, относящихся к планктону, живут на очень ограниченном пространстве и потребляют ресурсы одного рода (главным образом солнечную энергию и морские минеральные соединения). Современный подход к проблеме разделения экологической ниши несколькими видами указывает, что в некоторых случаях два вида могут разделять одну экологическую нишу, а в некоторых такое совмещение приводит один из видов к вымиранию.

Вообще, если речь идёт о конкуренции за определённый ресурс, становление биоценозов связано с расхождением экологических ниш и уменьшением уровня межвидовой конкуренции. При таком варианте правило конкурентного исключения подразумевает пространственное (иногда функциональное) разобщение видов в биоценозе. Абсолютное вытеснение, при подробном изучении экосистем, зафиксировать почти невозможно.

Таким образом, если два вида сосуществуют, то между ними должно быть какое-то экологическое различие, а это означает, что каждый из них занимает свою особую нишу.

Конкурируя с более сильным видом, слабый конкурент утрачивает свою реализованную нишу. Таким образом, выход из конкуренции достигается расхождением требований к среде, изменению образа жизни или, другими словами, является разграничением экологических ниш видов. В этом случае они приобретают способность сосуществовать в одном биоценозе. Так, в мангровых зарослях побережья Южной Флориды обитают самые разные цапли и нередко на одной и той же отмели кормятся рыбой до девяти разных видов. При этом они практически не мешают друг другу, так как в их поведении — в том, какие охотничьи участки они предпочитают и как ловят рыбу, — выработались приспособления, позволяющие им занимать различные ниши в пределах одной и той же отмели.

Однако когда мы наблюдаем сосуществование двух конкурентов, часто бывает трудно установить, что их ниши разделены, и невозможно доказать об ратное. Если экологу не удается обнаружить разделение ниш, то это может просто означать, что он искал его не там или не так. В XX веке принцип конкурентного исключения получил широкое признание из-за многочисленности подтверждающих его фактов; наличия некоторых теоретические предпосылок, свидетельствующих в его пользу, например, модели Лотки — Вольтерры.

Обобщённый принцип конкурентного исключения для произвольного числа ресурсных конкурентов снимает существовавшие противоречия между теорией и наблюдаемым богатством видов в природе:

> *Если конкурент полностью предотвращает любое использование по меньшей мере одного необходимого ресурса всеми его конкурентами, а сам всегда имеет доступ ко всем необходимым ресурсами и возможность их использовать, то, при прочих равных условиях, все его конкуренты будут вытеснены.*

Task 14. Act out dialogues as if you were:

1. Joseph Grinnell and one of his students;
2. Charles Sutherland Elton and his student;
3. G. Evelyn Hutchinson and his student

Explain your theory about the niche, give the main definitions.

2.4 ECOSYSTEM

PRE-READING

Task 1. Read, translate and give the transcription of the words. Consult your dictionary if necessary.

Biotic, abiotic, humidity, perish, photosynthesis, herbivore, carnivore, shallow, aquatic, prairie, canopy, malaria, nutrient, absorb, patch, agribusiness, farmland, medicines, income, housing, industry.

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What is ecosystem?

2. What does it consist of?

3. What is the human impact on ecosystems?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

Ecosystem

An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together to form a bubble of life. Ecosystems contain biotic or living, parts, as well as abiotic factors, or nonliving parts. Biotic factors include plants, animals, and other organisms. Abiotic factors include rocks, temperature, and humidity.

Every factor in an ecosystem depends on every other factor, either directly or indirectly. A change in the temperature of an ecosystem will often affect what plants will grow there, for instance. Animals that depend on plants for food and shelter will have to adapt to the changes, move to another ecosystem, or perish.

Ecosystems can be very large or very small. Tide pools, the ponds left by the ocean as the tide goes out, are complete, tiny ecosystems. Tide pools contain seaweed, a kind of algae, which uses photosynthesis to create food. Herbivores such as abalone eat the seaweed. Carnivores such as sea stars eat other animals in the tide pool, such as clams or mussels. Tide pools depend on the changing level of ocean water. Some organisms, such as seaweed, thrive in an aquatic environment, when the tide is in and the pool is full. Other organisms, such as hermit crabs, cannot live underwater and depend on the shallow pools left by low tides. In this way, the biotic parts of the ecosystem depend on abiotic factors.

The whole surface of Earth is a series of connected ecosystems. Ecosystems are often connected in a larger biome. Biomes are large sections of land, sea, or atmosphere. Forests, ponds, reefs, and tundra are all types of biomes, for example. They're organized very generally, based on the types of plants and animals that live in them. Within each forest, each pond, each reef, or each section of tundra, you'll find many different ecosystems.

Threats to Ecosystems

For thousands of years, people have interacted with ecosystems. Many cultures developed around nearby ecosystems. Many Native American tribes of North Americas Great Plains developed a complex lifestyle based on the native plants and animals of plains ecosystems, for instance. Bison, a large grazing animal native to the Great Plains, became the most important biotic factor in many Plains Indians cultures, such as the Lakota or Kiowa. Bison are sometimes mistakenly called buffalo. These tribes used buffalo hides for shelter and clothing, buffalo meat for food, and buffalo horn for tools. The tall grass prairie of the Great Plains supported bison herds, which tribes followed throughout the year. As human populations have grown, however, people have overtaken many ecosystems. The tallgrass prairie of the Great Plains, for instance, became farmland. As the ecosystem shrunk, fewer bison could survive. Today, a few herds survive in protected ecosystems such as Yellowstone National Park. In the tropical rain forest ecosystems surrounding the Amazon River in South America, a similar situation is taking place. The Amazon rain forest includes hundreds of ecosystems, including canopies, understories, and forest floors. These ecosystems support vast food webs. Canopies are ecosystems at the top of the rainforest, where tall, thin trees such as figs grow in search of sunlight. Canopy ecosystems also include other plants, called epiphytes, which grow directly on branches. Understory ecosystems exist under the canopy. They are darker and more humid than canopies. Animals such as monkeys live in understory ecosystems, eating fruits from trees as well as smaller animals like beetles. Forest floor ecosystems support a wide variety of flowers, which are fed on by insects like butterflies. Butterflies, in turn, provide food for animals such as spiders in forest floor ecosystems.

Human activity threatens all these rain forest ecosystems in the Amazon. Thousands of acres of land are cleared for farmland, housing, and industry. Countries of the Amazon rain forest, such as Brazil, Venezuela, and Ecuador, are underdeveloped. Cutting down trees to make room for crops such as soy and corn benefits many poor farmers. These resources give them a reliable source of income and food. Children may be able to attend school, and families are able to afford better health care. However, the destruction of rain forest ecosystems has its costs. Many modern medicines have been developed from rain forest plants. Curare, a muscle relaxant, and quinine, used to treat malaria, are just two of these medicines. Many scientists worry that destroying the rain forest ecosystem may prevent more medicines from being developed. The rain forest ecosystems also make poor farmland. Unlike the rich soils of the Great Plains, where people destroyed the tallgrass prairie ecosystem, Amazon rain forest soil is thin and has few nutrients. Only a few seasons of crops may grow before all the nutrients are absorbed. The farmer or agribusiness must move on to the next patch of land, leaving an empty ecosystem behind.

Rebounding Ecosystems

Ecosystems can recover from destruction, however. The delicate coral reef ecosystems in the South Pacific are at risk due to rising ocean temperatures and decreased salinity. Corals bleach, or lose their bright colors, in water that is too warm. They die in water that isn't salty enough. Without the reef structure, the ecosystem collapses. Organisms such as algae, plants such as seagrass, and animals such as fish, snakes, and shrimp disappear. Most coral reef ecosystems will bounce back from collapse. As ocean temperature cools and retains more salt, the brightly colored corals return. Slowly, they build reefs. Algae, plants, and animals also return. Individual people, cultures, and governments are working to preserve ecosystems that are important to them. The government of Ecuador, for instance, recognizes ecosystem rights in the country's constitution. The so-called Rights of Nature says Nature or *Pachamama*[Earth], where life is reproduced and exists, has the right to exist, persist, maintain and regenerate its vital cycles, structure, functions and its processes in evolution. Every person, people, community or nationality, will be able to demand the recognitions of rights for nature before the public bodies. Ecuador is home not only to rain forest ecosystems, but also river ecosystems and the remarkable ecosystems on the Galapagos Islands.

(Retrieved from: http://education.nationalgeographic.com/encyclopedia/ecosystem/)

Vocabulary

- Humidity [hjuːˈmɪdəti] - влажность
- Affect [əˈfekt] – воздействовать, влиять
- Shelter [ˈʃeltə(r)] – убежище, приют, укрытие
- Perish [ˈperɪʃ] – погибать, умирать
- Collapse [kəˈlæps] – крах, гибель, упадок

Word study

Task 4. Match the words with their appropriate meanings.

1. perish	a. волна, течение
2. tide	b.доход
3. surface	c.пустой
4. prairie	d. гибнуть, умирать
5. survive	e.соленость
6. herd	f.степь, прерия
7. canopy	g.креветка
8. income	h.стадо
9. absorb	i.удивительный, поразитель-ный
10. empty	j.впитывать
11. salinity	k. поверхность
12. shrimp	l.оставаться, продолжать существовать
13. remarkable	m.выживать
14. persist	n.навес, тент, верхняя крона

Task 5. Give the English equivalents.

1. живой
2. неживой
3. влажность
4. фактор
5. адаптироваться, приспосабливаться
6. фотосинтез
7. плотоядные
8. травоядные
9. соединять
10. развивать
11. укрытие, убежище
12. обеспечить
13. огромное разнообразие
14. предотвращать
15. лекарство

Comprehension and discussion

Task 6. Answer the questions.

1. What is “ecosystem”?
2. Name the main biotic/abiotic factors.
3. In what way do these factors of the ecosystem depend on each other?
4. Are different ecosystems connected with each other? In what way?
5. How do the people influence ecosystems?
6. What is a “canopy/understory/forest floor ecosystem”?
7. What is happening in the Amazon rainforest area because of the human activity?
8. Can ecosystems recover from destruction? Give the examples.

Task 7. Speak on the given topic using the following words and word combinations:

1. “Ecosystem is …” :

adapt, biotic, organism, temperature, humidity, factor, depend, abiotic factors

2. The sizes of ecosystems:

tiny ecosystems, aquatic, underwater, ocean water, tide pools

3. Threats to ecosystems:

interacted, develop, overtake, shrunk, survive, include, protected ecosystems, human activity, farmland, nutrients

4. Rebounding ecosystems:

recover, destruction, at risk, collapse, preserve, rights, regenerate

Task 8. Fill in the gaps using appropriate prepositions.

An ecosystem is a natural unit consisting 1___all plants, animals and microorganisms (biotic factors) in an area functioning together 2 all of the non-living physical (abiotic) factors of the environment.

Central to the ecosystem concept is the idea that living organisms are continually engaged 3___ a highly interrelated set 4___ relationships with every other element constituting the environment in which they exist. Eugene Odum, one of the founders of the science of ecology, stated: "Any unit that includes all of the organisms (ie: the "community") in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (ie: exchange of materials between living and nonliving parts) within the system is an ecosystem."The human ecosystem concept is then grounded in the deconstruction of the human/nature dichotomy, and the emergent premise that all species are ecologically integrated 5 each other, as well as with the abiotic constituents of their biotope.

A greater degree of species or biological diversity - popularly referred 6 as Biodiversity - of an ecosystem may contribute to greater resilience of an ecosystem, because there are more species present at a location to respond to change and thus "absorb" or reduce its effects. This reduces the effect before the ecosystem's structure is fundamentally changed to a different state. This is not universally the case and there is no proven relationship 7_____ the species diversity of an ecosystem and its ability to provide goods and services on a sustainable level: Humid tropical forests produce very few goods and direct services and are extremely vulnerable to change, while many temperate forests readily grow back to their previous state of development within a lifetime after felling or a forest fire. Some grasslands have been sustainably exploited 8 thousands 9 years (Mongolia, Africa, European peat and mooreland communities).

The term ecosystem can also pertain to human-made environments, such as human ecosystems and human-influenced ecosystems, and can describe any situation where there is relationship between living organisms and their environment. Fewer areas on the surface of the earth today exist free 10___human contact, although some genuine wilderness areas continue to exist without any forms 11___human intervention.

(Retrieved from: https://en.wikipedia.org/wiki/Natural_environment)

Task 9. Choose one of the topics to make a report and present it in front of the class.

1. The notion of ‘ecosystem’.
2. Examples of ecosystems in your country.
3. The main problems of modern ecosystems.

UNIT 3. BIOSPHERE

PRE-READING

Task 1. This is just a partial listing of some of the many, many different possible fields of study within science. Many of the fields listed here overlap to some degree with one or more other areas. Consult the dictionary and read the names of the sciences correctly.

Acoustics, astrodynamics, astronomy, astrophysics, biophysics, classical mechanics, computational physics, computational chemistry, electrochemistry, inorganic chemistry, materials science, organic chemistry, anatomy, astrobiology, biochemistry, bioinformatics, biophysics, botany, cell biology, marine biology, microbiology, cryogenics, entomology, epidemiology, developmental biology, geodesy, geography, geology, hydrology, taxonomy, toxicology, virology, zoology, meteorology, oceanography, paleontology, seismology.

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What do you know about the term *biosphere*?
2. What is the role of the Russian scientists in establishment of the term "*biosphere*"?
3. Which sciences study biosphere?
4. What systems invented by men help to study the world around us?
5. Can life exist the other planets of the solar system? Why?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

Biosphere

The biosphere is the biological component of earth systems, which also include the lithosphere, hydrosphere, atmosphere and other "spheres" (e.g. cryosphere, anthrosphere, etc.). The biosphere includes all living organisms on earth, together with the dead organic matter produced by them.

The biosphere concept is common to many scientific disciplines including astronomy, geophysics, geology, hydrology, biogeography and evolution, and is a core concept in ecology, earth science and physical geography. A key component of earth systems, the biosphere interacts with and exchanges matter and energy with the other spheres, helping to drive the global biogeochemical cycling of carbon, nitrogen, phosphorus, sulfur and other elements. From an ecological point of view, the biosphere is the "global ecosystem", comprising the totality of biodiversity on earth and performing all manner of biological functions, including photosynthesis, respiration, decomposition, nitrogen fixation and denitrification.

The biosphere is dynamic, undergoing strong seasonal cycles in primary productivity and the many biological processes driven by the energy captured by photosynthesis. Seasonal cycles in solar irradiation of the hemispheres is the main driver of this dynamic, especially by its strong effect on terrestrial primary productivity in the temperate and boreal biomes, which essentially cease productivity in the winter time. The biosphere has evolved since the first single-celled organisms originated 3.5 billion years ago under atmospheric conditions resembling those of our neighboring planets Mars and Venus, which have atmospheres composed primarily of carbon dioxide. Billions of years of primary production by plants released oxygen from this carbon dioxide and deposited the carbon in sediments, eventually producing the oxygen-rich atmosphere we know today. Free oxygen, both for breathing ($O2$, respiration) and in the stratospheric ozone ($O3$) that protects us from harmful UV radiation, has made possible life as we know it while transforming the chemistry of earth systems forever.

As a result of long-term interactions between the biosphere and the other earth systems, there is almost no part of the earth's surface that has not been profoundly altered by living organisms. The earth is a living planet, even in terms of its physics and chemistry. A concept related to, but different from, that of the biosphere, is the Gaia hypotheses, which posits that living organisms have and continue to transform earth systems for their own benefit.

The term "biosphere" originated with the geologist Eduard Suess in 1875, who defined it as "the place on earth's surface where life dwells". Vladimir I. Vernadsky first defined the biosphere in a form resembling its current ecological usage in his long-overlooked book of the same title, originally published in 1926. It is Vernadsky's work that redefined ecology as the science of the biosphere and placed the biosphere concept in its current central position in earth systems science.

The biosphere is a core concept within Biology and Ecology, where it serves as the highest level of biological organization, which begins with parts of cells and proceed to populations, species,ecoregions, biomes and finally, the biosphere. Global patterns of biodiversity within the biosphere are described using biomes.

In earth science, the biosphere represents the role of living organisms and their remains in controlling and interacting with the other spheres in the global biogeochemical cycles and energy budgets. The biosphere plays a central role in the biogeochemical processing of carbon, nitrogen, phosphorus, sulfur and other elements. As a result, biogeochemical processes such as photosynthesis and nitrogen fixation are critical to understanding the chemistry and physics of earth systems as a whole. The physical properties of the biosphere in terms of its surface reflectance (albedo) and exchange of heat and moisture with the atmosphere are also critical for understanding global circulation of heat and moisture and therefore climate. Alterations in both the physics (albedo, heat exchange) and chemistry (carbon dioxide, methane, etc.) of earth systems by the biosphere are fundamental in understanding anthropogenic global warming.

Researchers make direct observations on the biosphere using global remote sensing platforms. Beginning in the 1980s (AVHRR), this effort has evolved into advanced remote sensing systems that can scan the entire surface of the earth at least once each day (MODIS). These observations are now used to quantify the activities of the biosphere, primarily in terms of vegetation cover and function, using spectral indices such as NDVI. Future remote sensing efforts will directly observe global patterns of carbon dioxide exchange with the biosphere caused by photosynthesis, respiration and the combustion of biomass and fossil fuels (OCO).

(Retrieved from: http://www.eoearth.org/view/article/150667/)

Vocabulary

- AVHRR (Advanced Very High Resolution Radiometer) [ədˈvɑːnst ˈveri haɪ ˌrezəˈluːʃn ˌreɪdiəʊˈmiːtə(r)] - электронно- оптическая система, радиометр высокого разрешения
- MODIS (Moderate Resolution Imaging Spectroradiometer) [ˈmɒdərət ˌrezəˈluːʃn ˈɪmɪdʒɪŋ spekˈtrɒˌreɪdiəʊˈmiːtə(r)] - Сканирующий спектрорадиометр среднего разрешения
- NCVI (Normalised Difference Vegetation Index) [ˈnɔːməlaɪzd ˈdɪfrəns ˌvedʒəˈteɪʃn ˈɪndeks] - Нормализованно- разностный вегетационный индекс
- OCO (operational capabilities objective) [ˌɒpəˈreɪʃənl ˌkeɪpəˈbɪlətiz əbˈdʒektɪv] - требуемые рабочие характеристики

Word study

Task 4. Make pairs out of the following words from the text.

1.	remote	a.	cycles
2.	core	b.	fuels
3.	biological	c.	properties
4.	living	d.	of heat
5.	biogeochemical	e.	warming
6.	nitrogen	f.	sensing
7.	physical	g.	of biomass
8.	fossil	h.	surface
9.	circulation	i.	fixation
10.	global	j.	concept
11.	earth	k.	organization
12.	combustion	l.	organisms

Task 5. Match the words and word combinations with their equivalents in Russian.

1.	matter	a.	круговорот
2.	core	b.	разложение
3.	to interact	c.	северный
4.	cycling	d.	профильный
5.	respiration	e.	напоминать
6.	decomposition	f.	осадок, отложение
7.	temperate	g.	материя
8.	boreal	h.	текущий, поток
9.	condition	i.	умеренный
10.	to resemble	j.	взаимодействовать
11.	to deposit	k.	условие
12.	sediment	l.	дыхание
13.	to define	m.	определять
14.	current	n.	помещать
15.	albedo	o.	отражающая способность

Task 6. Translate the sentences from Russian into English.

1. Биосфера — оболочка Земли, населенная живыми организмами.

2. Биосфера включает нижнюю часть атмосферы, гидросферу и верхнюю часть литосферы.

3. Основоположником учения о биосфере является В.И. Вернадский.

4. Он подчеркивал, что биосфера — результат сложнейшего механизма геологического и биологического развития и взаимодействия косного и биогенного вещества.

5. Живое вещество биосферы — совокупность всех ее живых организмов.

6. Высшую стадию развития биосферы Вернадский назвал ноосферой, когда разумная деятельность человека является определяющим фактором развития жизни.

7. Основа стабильности биосферы -биологическое разнообразие всего живого на Земле — от генов до экосистем.

Task 7. Insert prepositions where necessary.

1. The term Biosphere was first used a century ago__ the Austrian geologist Eduard Suess as a sphere living organism or biological process lying the interface between the atmosphere, lithosphere and hydrosphere.

2. Replacement___ the communities___ nature____ man made communities have to be observed if these man-made communities are to thrive.

3. To safeguard life____earth, people must learn to control and adjust the balances nature that are altered their activities.

4. It is estimated that the biosphere contains more than 350,000 species plants including algae, fungi, mosses and higher forms_ plants,__ eleven million animal species ranging uni-cellular protozoa man.

5. The organic continuity the system rests a delicate network interdependent relationship.

6. The process which solar energy is transferred molecules is called photochemical process.

7. It is oxidants and reluctant that assist plants__ producing carbohydrates and oxygen, molecules carbon dioxide and water.

Comprehension and discussion

Task 8. Answer the questions.

8. Biosphere is the biological component of earth systems, isn’t it?

9. Which disciplines use the term “biosphere”?
10. Where do the seasonal cycles occur?
11. When did the first single-celled organism emerge?
12. What idea does the Gaia hypotheses state?
13. What do you know about the history of the term “biosphere”?
14. What chemical elements do you know?
15. What are the ways of studing the Earth’s biosphere?

Task 9. Are these statements true or false? Explain your opinion according to the text.

9. The term *Biosphere* was first used a century ago by the Austrian geologist Eduard Suess as a sphere of living organism or biological process lying at the interface between the atmosphere, lithosphere and hydrosphere.
10. People must think less about conquering nature and more about learning to work with nature.
11. In addition, each person must realize his independence with the rest of nature, including his fellow human beings.
12. To safeguard life on earth, people must learn to control and adjust the balances in nature that are altered by their activities.
13. It is estimated that the biosphere contains only 350 species of plants including algae, fungi, mosses and higher forms of plants, from eleven million animal species ranging from uni-cellular protozoa to man.
14. The biosphere supplies the essential species, namely light, heat, water, food and living space or habitats.
15. The air, the water, man and the animals, plants and planktons, the soil and bacteria are not interlinked in a life-sustaining system, we call the environment.
16. The most important photochemical activity in the biosphere is photosynthesis in plants.

Task 10. Make up short dialogues using the given words and phrases.

- Biosphere, system, to produce, matter
- Disciplines, core, to interact, cycling
- Photosynthesis, solar, temperate, boreal
- Interactions, to alter, benefit, living
- Sensing, surface, combustion, fossil

Task 11. Choose best word to fill the gap:

Bacteria, ecosystems, biosphere, system, soil, gases, oxygen(2), organisms, plants(2), prokaryotes, animals, unit, water, food.

The origin of the Biosphere.

The__________has existed for about 3.5 billion years. The biosphere's earliest life-forms, called prokaryotes, survived without_______. Ancient prokaryotes included single-celled____________such as bacteria and archaea.

Some____________developed a unique chemical process. They were able to use sunlight to make simple sugars and oxygen out of__________and carbon dioxide, a process calledphotosynthesis. These photosynthetic organisms were so plentiful that they changed the biosphere. Over a long period of time, the atmosphere developed a mix of oxygen and other___________that could sustain new forms of life.

The addition of__________to the biosphere allowed more complex life-forms to evolve. Millions of different____________and other photosynthetic species developed.__________, which consume plants (and other animals) evolved. ____________ and other organisms evolved to decompose, or break down, dead animals and plants.

The biosphere benefits from this_________web. The remains of dead plants and animals release nutrients into the__________and ocean. These nutrients are reabsorbed by growing__________. This exchange of food and energy makes the biosphere a self-supporting and self-regulating ___________________.

The biosphere is sometimes thought of as one large ecosystem—a complex community of living and nonliving things functioning as a single ___________. More often, however, the biosphere is described as having many____________.

Task 12. Translate the text and retell it in English:

Biosphere 2 In 1991, a team of eight scientists moved into a huge, self-contained research facility called Biosphere 2 in Oracle, Arizona. Inside an enormous, greenhouse-like structure, Biosphere 2 created five distinct biomes and a working agricultural facility. Scientists planned to live in Biosphere 2 with little contact with the outside world. The experiments carried out in Biosphere 2 were designed to study the relationship between living things and their environmentand to see whether humans might be able to live in space one day.

The mission was supposed to last 100 years, with two teams of scientists spending 50 years each in the facility. Instead, two teams made it just four years, and the scientists moved out in 1994. Though the live-in phase is over, research is still taking place in Biosphere 2, with a main focus on global warming.

The biosphere is made up of the parts of Earth where life exists. The biosphere extends from the deepest root systems of trees, to the dark environment of ocean trenches, to lush rain forests and high mountaintops.

Scientists describe the Earth in terms of spheres. The solid surface layer of the Earth is the lithosphere. Theatmosphere is the layer of air that stretches above the lithosphere. The Earth's water—on the surface, in the ground, and in the air—makes up the hydrosphere.

Since life exists on the ground, in the air, and in the water, the biosphere overlaps all these spheres. Although the biosphere measures about 20 kilometers (12 miles) from top to bottom, almost all life exists between about 500 meters (1,640 feet) below the ocean's surface to about 6 kilometers (3.75 miles) above sea level.

Task 13. Render this text in English:

Крупнейшим обобщением в комплексе наук о Земле (геология, география, геохимия, биология) стало учение о биосфере, созданное русским ученым В. И. Вернадским. Начав свою научную деятельность (как геолог) с изучения осадочных пород земной коры, В. И. Вернадский выявил огромную роль живых организмов в сложных геохимических процессах нашей планеты. В 1926 г. вышла его книга «Биосфера». В этом произведении глубоко анализируются сложные взаимоотношения живых организмов и неживой природы Земли. Его работа несколько опередила время. Лишь во второй половине XX в., на фоне обострения экологических проблем, его учение о биосфере получило широкое распространение.

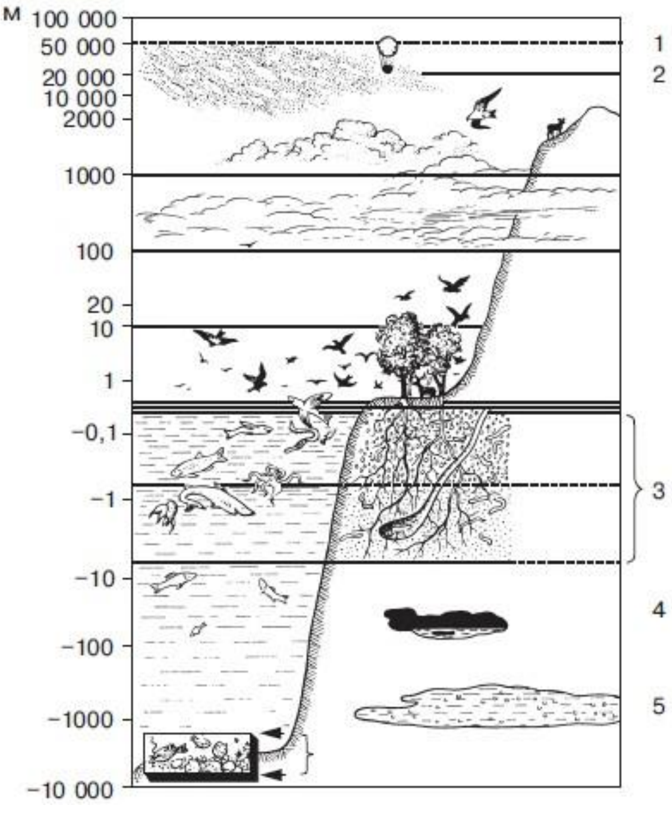
Важным элементом учения В. И. Вернадского о биосфере является идея тесной зависимости биосферы от деятельности человека и сохранности ее в результате разумного отношения человека к природе. Ученый писал: Человечество, взятое в целом, становится мощной геологической силой. Перед ним, перед его мыслью и трудом становится вопрос о перестройке биосферы в интересах свободно мыслящего человечества как единого целого. Это новое состояние биосферы, к которому мы, не замечая этого, приближаемся, и есть ноосфера.[1]

В настоящее время учение о биосфере представляет собой важнейшую часть экологии, непосредственно связанную с проблемами регулирования взаимодействия человека и природы.

Впервые термин «биосфера» был употреблен Ж. Б. Ламарком в начале XIX в. Позднее он был упомянут в работе австрийского геолога Э. Зюсса в 1875 г. Однако это понятие не было детально разработано названными учеными, а использовано вскользь для обозначения области жизни на Земле. Лишь в работах В. И. Вернадского оно анализируется детально и тщательно и под ним понимается «оболочка жизни» на нашей планете.

Биосферой называют совокупность всех живых организмов нашей планеты и те области геологических оболочек Земли, которые заселены живыми существами и подвергались в течение геологической истории их воздействию.

Границы биосферы. Живые организмы неравномерно распространены в геологических оболочках Земли: *литосфере, гидросфере и атмосфере* (рис. 1). Поэтому биосфера сейчас включает верхнюю часть литосферы, всю гидросферу и нижнюю часть атмосферы.



Task 14. Choose one of the topics to make a report and present it in front of the class.

a. Human impact on biosphere.

b. The term “biosphere”, it’s origin and it’s meaning.
c. The cycles of the biosphere.
d. The importance of natural sciences.

Task 15. Read and translate the information below. Make up 10-12 questions of different types, the answers to which could cover the main ideas of the text.

The pedosphere (from Greek πέδον pedon "soil" or "earth" and σφαίρα sfaíra "sphere") is the outermost layer of the Earth that is composed of soil and subject to soil formation processes. It exists at the interface of the lithosphere, atmosphere, hydrosphere and biosphere. The sum total of all the organisms, soils, water and air is termed as the "pedosphere".

The pedosphere is the skin of the Earth and only develops when there is a dynamic interaction between the atmosphere (air in and above the soil), biosphere (living organisms), lithosphere (unconsolidated regolith and consolidated bedrock) and the hydrosphere (water in, on and below the soil). The pedosphere is the foundation of terrestrial life on this planet. There is a realization that the pedosphere needs to be distinctly recognized as a dynamic interface of all terrestrial ecosystems and be integrated into the Earth System Science knowledge base.

The pedosphere acts as the mediator of chemical and biogeochemical flux into and out of these respective systems and is made up of gaseous, mineralic, fluid and biologic components. The pedosphere lies within the Critical Zone, a broader interface that includes vegetation, pedosphere, groundwater aquifer systems, regolith and finally ends at some depth in the bedrock where the biosphere and hydrosphere cease to make significant changes to the chemistry at depth. As part of the larger global system, any particular environment in which soil forms is influenced solely by its geographic position on the globe as climatic, geologic, biologic andanthropogenic changes occur with changes in longitude and latitude.

The pedosphere lies below the vegetative cover of the biosphere and above the hydrosphere and lithosphere. The soil forming process (pedogenesis) can begin without the aid of biology but is significantly quickened in the presence of biologic reactions. Soil formation begins with the chemical and/or physical breakdown of minerals to form the initial material that overlies the bedrock substrate. Biology quickens this by secreting acidic compounds (dominantly fulvic acids) that help break rock apart. Particular biologic pioneers are lichen, mosses and seed bearing plants[2] but many other inorganic reactions take place that diversify the chemical makeup of the early soil layer. Once weathering and decomposition products accumulate, a coherent soil body allows the migration of fluids both vertically and laterally through the soil profile causing ion exchange between solid, fluid and gaseous phases. As time progresses, the bulk geochemistry of the soil layer will deviate away from the initial composition of the bedrock and will evolve to a chemistry that reflects the type of reactions that take place in the soil.

UNIT 4. LITHOSPHERE

PRE-READING

Task 1. Read and translate the names of natural disasters, use dictionary if necessary.

Drought, earthquake, extreme heat, flood, hurricane, landslides, debris flow, severe weather, thunderstorm, lightning, tornado, tsunami, volcano eruption, wildfire, winter storm, extreme cold.

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What do you know about the term *lithosphere*?
2. Would you like to take part in the environment protection programs?
3. How do people alter the surface of the Earth?
4. Which regions have problems with earthquakes and volcanos' erup- tions?
5. What do you know about Pangaea?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

What are lithosphere programs?

The Lithosphere Program also known as the International Lithosphere Program (ILP) focuses to understand the beginning, transformations, dynamics, and nature of the lithosphere of planet Earth and to conducts projects of awareness worldwide. ILP emphasis on the difference between the 'desire to understand the causes of societal needs' for e.g. a natural disaster, a catastrophe that may change the earth's atmosphere and geography and 'the desire to know more about scientific destructions' that means the amount of destruction happening on a daily basis, which could be controlled or modified to create awareness about.

To understand the lithosphere programs, you first must understand what a lithosphere is and what it consists of. The lithosphere is the hard, outermost part of the earth. The layers of earth are divided into the outer crust, the middle mantle and the inner most core. The lithosphere surrounds the surface of the earth and is responsible for the movement of the tectonic plates. It comprises of the continents and extends up to 100 kilometers in length, all around the planet earth in a circle.

Scientists monitor the lithosphere layer because this layer is under constant motion, but it moves slow and steady. These movements are responsible for the movements of the tectonic plates. Tectonic plates are better known as fracture plates. It is believed that the movement occurs due to the generation of the heat from the mantle to the crust. The vast difference in the temperatures of the mantle and the crust cause these numerous fractures to occur. However, some suggest it is due to an external impact on the crust itself. The movement of these plates, or rubbing of these plates against each other, produces friction and is the cause of earthquakes.

The immediate inner layer to the crust and also a part of lithosphere is the Asthnosphere. The geologist Joseph Barrel suggested a hypothesis on the basis of the pulling force (gravity) of the Earth that since lithosphere is the outermost layer and farthest from the centre of the earth it must produce minimum gravity and must be stronger and more resistant than the weaker immediate inner layer that has greater effects of gravitational force. Another Geologist Reginald Aldworth Daly researched on these further to create awareness The reason scientists monitor this layer, is to keep track of any kind of activity that might help in the future to predict earthquakes and tsunamis. The lithosphere has been classified into Oceanic Lithosphere and Continental Lithosphere. Oceanic lithosphere is the part that is present on the basin of oceans. The Continental lithosphere however comprises of sedimentary rocks that form continents.

(Retrieved from: www.sclilp.org/what-are-lithosphere-programs/)

Vocabulary

- Awareness [əˈweənəs] - осведомленность
- Worldwide [ˌwɜːldˈwaɪd] - всемирный
- Emphasis [ˈemfəsɪs] – особое внимание
- Gravitational [ˌɡrævɪˈteɪʃənl] - гравитационный
- Sedimentary [ˌsedɪˈmentri] - осадочный

Word study

Task 4. With the help of your dictionary, make nouns out of the following verbs:

To arrive, to land, to depart, to approve, to refer, to immigrate, to divide, to erase, to legislate, to govern.

Task 5. Match the words with their appropriate meanings.

1. to focus	a. содержать, охватывать
2. to conduct	b. акцент, особое внимание
3. emphasis	c. тереть
4. cause	d. мантия
5. disaster	e. бедствие
6. destruction	f. тектонические плиты
7. amount	g. сфокусиро-вать · сосредоточивать
8. outermost	h. разрушение, уничтожение
9. crust	i. крайний
10. mantle	j. проводить
11. core	k. кора
12. tectonic plates	l. количество, величина
13. to comprise	m. обширный, многочислен-ный
14. vast	n. причина, основание
15. to rub	o. осадочный
16. sedimentary	p. ядро

Task 6. Choose the best variant and complete the gaps.

1. Earth's lithosphere_______________the crust and the uppermost mantle, which constitute the hard and rigid outer layer of the Earth.

   a. includes
   b. consists
   c. include

2. There______two types of lithosphere: oceanic and continental.

   a. are
   b. is
   c. be

3. The uppermost part of the lithosphere that chemically reacts to the atmosphere, hydrosphere and biosphere through the soil forming cess_______pedosphere.

   a. is called
   b. called

c. calls

4. Oceanic lithosphere thickens as it ages and moves away ________ the mid-ocean ridge.

a. on
b. of
c. from

5. The oldest oceanic lithosphere________about 170 million years old, while parts of the continental lithosphere_______billions of years old.

a. Are, is
b. Is, are
c. Is, is

Task 7. Give as many synonyms to the word as you can.

a. vast
b. amount
c. different
d. emphasis
e. to conduct
f. to comprise

Task 8. Make up sentences.

1. The __________ is the_______, _______ part of the_________. (lithosphere, hard, outermost, earth)
2. The____of earth are divided into the outer________, the middle ______ and the_____most___. (core, inner , layers, crust, mantle)
3. The____surrounds the____of the____and is responsible for the_____of the tectonic______. (surface, lithosphere, plates, earth, movement)
4. It ___ of the ___ and ___ up to 100 ___ in length, all around the ___ earth in a_______. (continents, planet, comprises, kilometers, extends, circle)
5. _______ plates _____ better _______ as fracture__________. (plates, known, are, tectonic)

6. The_______of these plates, or rubbing of these________against each other, produces _______ plates, plates.

Task 9. Find information about one of the ecological organizations listed above and present it in front of the class.

- Earth System Governance Project (ESGP)
- Global Environment Facility (GEF)
- Intergovernmental Panel on Climate Change (IPCC)
- International Union for Conservation of Nature (IUCN)
- United Nations Environment Programme (UNEP)
- World Nature Organization (WNO)
- Centre for Science and Environment (CSE)

UNIT 5. HYDROSPHERE

PRE-READING

Task 1. Complete the table. Use dictionairy if necessary.

word	part of speech	transcription	translation
entire			
origin			
ancient			
to circulate			
bottom			
liquid			
compound			
particle			
solid			
vapor			
glacier			
to assume			
to evaporate			
to condense			
to clump			
to drain			
to percolate			
aquifer			

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What do you know about the term *hydrosphere*?
2. What is the value of water on the Earth?
3. How do we use water in our everyday life but for drinking?
4. What vital problems with water on the earth can you name?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

Water, Water, Everywhere

Water is everywhere on Earth. About seventy percent of the surface of the Earth is covered by water. If you were an alien visiting the planet, you would see a giant blue sphere from space (especially on the Pacific Ocean side). Not only is water everywhere, but all life depends on water. The tiniest bacteria and the largest dinosaurs have all needed water. The hydrosphere is the world of water that surrounds all of us.

Because water is so important, it makes up an entire section of the earth sciences. You will probably hear the term "hydro" many times. The prefix “hydro” has origins in ancient Greek. You will learn about hydrologists that study water and the way it is used and circulated across the planet. Hydrology is the study of water. That water may be at the bottom of the ocean or in clouds found in the atmosphere. Anything related to water is a part of the hydrosphere.

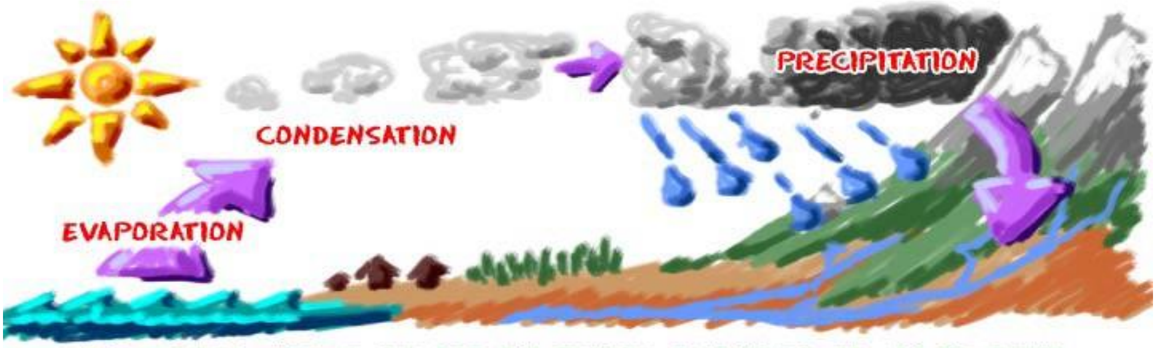
Importance of Liquid Water

Water is in the air, on the land, between the rocks, and in every living thing. Water, in its purest form, is the compound H_2O. There are twohydrogen (H) atoms bonded to oneoxygen (O) atom. Generally, you won’t find pure water. There are usually other compounds, ions, or particles mixed with water. While water may move and carry other substances with it, you need to remember that the small water molecules are the things that make life on Earth possible.

Liquid water makes the Earth a special place. Our planet has a very nice temperature range that allows water to remain in a liquid state. If we were a colder place like Pluto, all of the water would be permanently frozen and solid. On the other hand, if we were on a very hot planet, all of the water would be in a gas state. Water vapor and solid water are relatively useless to the organisms of Earth.

Things get interesting when you start to have a system with solid, liquid, and gas states of water. Because all of the states exist on Earth, they are all important to scientists. There are solids in the deep glaciers, liquids of the oceans, and the vapor state of clouds. While there might not be a lot of life in or on those glaciers, they will eventually melt. Once they melt, they start to affect all of the life on Earth. All of the physical states are equally important because they are all connected.

The Life of a Water Molecule



THE WATER CYCLE RELIES ON PHASE CHANGES TO MAKE RAIN.

Let’s say you're a water molecule. For this example we’ll assume you are staying a water molecule and not combining with other compounds. We’re going to have you move through the hydrologic cycle. You’ll start by sitting on the surface of the Pacific Ocean. All of a sudden you are filled with energy, evaporate, and move up into the atmosphere.

Winds are moving and you see yourself flying over the ocean towards land. Things start to get cold and all water vapor around you begins to condense. You all clump together and now you’re too heavy to stay in the clouds. You fall to the surface in a raindrop. If you are one of the first drops to fall, you might be absorbed into the soil. If you are at the end of a storm, you might wind up in runoff and drain into a river. From that river you could flow all the way back to the ocean and start your journey over again.

How much time does your journey take? Scientists think that if you are lucky enough to evaporate into a cloud, you spend about ten days floating around the atmosphere. If you're unlucky enough to be at the bottom of the ocean, percolate into an aquifer, or get stuck in a glacier, you might spend tens of thousands of years without returning to the hydrologic cycle. As of 2013, the oldest ice ever found was about 800,000 years old. That’s a long time to stay out of the water cycle.

(Retrieved from: http://geography4kids.com/files/water_intro.html)

Vocabulary

- Condensation [ˌkɒndenˈseɪʃn]– конденсация
- Evaporation [ɪˌvæpəˈreɪʃn] – испарение
- Precipitation [prɪˌsɪpɪˈteɪʃn] – атмосферные осадки
- Percolate [ˈpɜːkəleɪt] - просачиваться
- Aquifer [ˈækwɪfə(r)] – водоносный слой

Word study

Task 4. Match the words with their definitions.

1. to clump
2. to condense
3. to drain
4. to assume
5. to evaporate
6. to absorb
7. to percolate
8. to circulate

9. to combine
10. to allow

a. come together as in a cluster or flock
b. make it possible through a specific action or lack of action for something to happen
c. undergo condensation; change from a gaseous to a liquid state and fall in drops
d. put or add together
e. flow off gradually
f. move through a space, circuit or system, returning to the starting point
g. take to be the case or to be true; accept without verification or proof
h. spread gradually
i. lose or cause to lose liquid by vaporization leaving a more concentrated residue
j. become imbued

Task 5. Fill the table with antonyms and synonyms.

word	**antonyms**	**synonyms**
entire		
origin		
bottom		
ancient		
liquid		
solid		
compound		
heavy		
journey		

Task 6. For each geographical name, decide whether you need the definite article the **before it.**

1) ___ Europe
2) ___ Himalayas
3) ___ River Danube
4) ___ Asia
5) ___ Alps
6) ___ Spain
7) ___ Panama Canal
8) ___ Pacific Ocean
9) ___ Northern Ireland
10) ___ Black Sea
11) ___ Atlantic Ocean
12) ___Irish Republic
13) ___Bahamas
14) ___ Mount Etna

Task 7. Testing: Hydrosphere

What part of the earth's surface is occupied by the oceans?

a. 17%
b. 40%
c. 60%
d. 71%

Which flow called warm?

a. One in which water is warmer than 0 ° C
b. One in which water is warmer than 20 ° C
c. One in which water is warmer in the surrounding ocean water
d. One in which water never freezes

Which units measure the salinity of ocean water?

a. In grams per cubic liter
b. Percentage
c. In ppm
d. In kilograms per meter cubic

What is the name of the river valley, constantly occupied by water flow?

a. Flood bed
b. Channel

c. Terrace

d. Estuary

Factors depend on which tidal height?

a. Soundings

b. From the relative positions of Earth, Moon and Sun

c. From the time of year

d. From coast line

What is the maximum height of tides in the ocean?

a. Over 18 m

b. About 10 m

c. Not more than 0,5 m

How does the temperature of the ocean to a depth of 700 meters?

a. Virtually unchanged

b. Constantly decreasing

c. Continuing increases

d. Reduction and increase in temperature alternating

Which of the statements is wrong?

a. Near the bottom of the ocean water is colder, because there does not penetrate the sun's rays

b. At great depths all the water has the same temperature, close to 0 ° C

c. Near the bottom of the water getting warmer, because the substance is heated with warm mantle that overlies relatively shallow

What are the aggregate states characteristic of water?

a. Gaseous

b. Liquid

c. Viscous

d. Solid

As the process called when water evaporating over the ocean, and transferred on dry land after the loss of surface flows into the ocean on the surface or underground prosochuyuchys?

a. Flow

b. Seepage

c. A small circuit

d. Great circulation

As called solid performances over the rocks down the river in separate blocks of stone?

a. Waterfall

b. Fall

c. Dam

d. Thresholds

How are called lakes, caused by soluble rocks?

a. Lake-old women

b. Ice

c. Karst

d. Lymanne

Task 8. Translate from Russian into English.

Гидросфера – водная оболочка нашей планеты, включает в себя всю воду, химически не связанную, независимо от ее состояния (жидкую, газообразную, твердую). Гидросфера является одной из геосфер, располагающейся между атмосферой и литосферой. Эта прерывистая оболочка включает все океаны, моря, континентальные пресные и соленые водоемы, ледяные массивы, атмосферную воду и воду в живых существах.

Примерно 70% поверхности Земли покрыты гидросферой. Ее объем около 1400 млн. кубометров, что составляет 1/800 объема всей планеты. 98% вод гидросферы – Мировой океан, 1,6 % заключено в материковых льдах, остальная часть гидросферы приходится на долю пресных рек, озер, подземных вод. Таким образом, гидросфера делится на Мировой океан, подземные воды и континентальные воды, причем каждая группа, в свою очередь, включает подгруппы более низких уровней. Так, в атмосфере вода находится в стратосфере и тропосфере, на земной поверхности выделяют воды океанов, морей, рек, озер, ледников, в литосфере – воды осадочного чехла, фундамента.

Несмотря на то, что основная масса воды сосредоточена в океанах и морях, а на долю поверхностных вод приходится лишь малая часть гидросферы (0,3%), именно они играют главную роль в существовании биосферы Земли. Поверхностные воды – это основной источник водоснабжения, обводнения и орошения. В зоне водообмена пресные подземные воды быстро обновляются в ходе общего круговорота воды, поэтому при рациональной эксплуатации можно использовать их неограниченно долгий срок.

В процессе развития молодой Земли гидросфера формировалась при становлении литосферы, которая за геологическую историю нашей планеты выделила огромное количество водяного пара и подземных магматических вод. Гидросфера образовалась в ходе длительной эволюции Земли и дифференциации ее структурных компонентов. В гидросфере впервые на Земле зародилась жизнь. Позднее в начале палеозойской эры состоялся выход живых организмов на сушу, и началось постепенное расселение их на континентах. Жизнь без воды невозможна. В тканях всех живых организмов содержится до 70-80% воды.

Воды гидросферы постоянно взаимодействуют с атмосферой, земной корой литосферы и биосферой. На границе между гидросферой и литосферой формируются практически все осадочные горные породы, которые составляют осадочный слой земной коры. Гидросферу можно рассматривать как часть биосферы, так как она полностью заселена живыми организмами, которые, в свою очередь, оказывают влияние на состав гидросферы. Взаимодействие вод гидросферы, переход воды из одного состояния в другое проявляется как сложный круговорот воды в природе. Все виды круговорота воды различных объемов представляют собой единый гидрологический цикл, в ходе которого осуществляется возобновление всех типов вод. Гидросфера является незамкнутой системой, воды которой тесно взаимосвязаны, что обусловливает единство гидросферы как природной системы и взаимовлияние гидросферы и других геосфер.

Task 9. Read and translate the text. Ask 10 questions of different types to cover the contents of the text. Retell the text, answering the questions you have written.

An award-winning book titled Water by Marq de Villiers described the hydrosphere as a closed system in which water exists. The hydrosphere is intricate, complex, interdependent, all-pervading and stable and "seems purpose-built for regulating life (de Villiers 2003:26)." De Villiers claimed that, "On earth, the total amount of water has almost certainly not changed since geological times: what we had then we still have. Water can be polluted, abused, and misused but it is neither created nor destroyed, it only migrates. There is no evidence that water vapor escapes into space (page 26)."

"Every year the turnover of water on Earth involves 577,000 km^3 of water. This is water that evaporates from the oceanic surface (502,800 km3) and from land (74,200 km^3). The same amount of water falls as atmospheric precipitation, 458,000 km^3 on the ocean and 119,000 km^3 on land. The difference between precipitation and evaporation from the land surface (119,000 - 74,200 = 44,800 km^3/year) represents the total runoff of the Earth's rivers (42,700 km^3/year) and direct groundwater runoff to the ocean (2100 km^3/year). These are the principal sources of fresh water to support life necessities and man's economic activities."

Water is a basic necessity of life. Since 2/3 of the Earth is covered by water, the Earth is also called the blue planet and the watery planet. Hydrosphere plays an important role in the existence of the atmosphere in its present form. Oceans are important in this regard. When the Earth was formed it had only a very thin atmosphere rich in hydrogen and helium similar to the present atmosphere of Mercury. Later the gases hydrogen and helium were expelled from the atmosphere. The gases and water vapor released as the Earth cooled became our present atmosphere. Other gases and water vapor released by volcanoes also entered the atmosphere. As the Earth cooled the water vapor in the atmosphere condensed and fell as rain. The atmosphere cooled further as atmospheric carbon dioxide dissolved in to rain water. In turn this further caused the water vapor to condense and fall as rain. This rain water filled the depressions on the Earth's surface and formed the oceans. It is estimated that this occurred about 4000 million years ago. The first life forms began in the oceans. These organisms did not breathe oxygen. Later, when cyanobacteria evolved, the process of conversion of carbon dioxide into food and oxygen began. As a result, our atmosphere has a distinctly different composition from that of the other planets; it is a fundamental requirement for life on Earth.

Task 10. Study the list of English and Metric unit abbreviations. Translate the names of the units of measurement and practise to read them.

English Unit Abbreviations

Abbreviation	Unit of Measurement
bbl.	barrel
cu.	cubic
doz.	dozen
F., F	Fahrenheit
fl. oz.	fluid ounce
ft.	foot
gal.	gallon
gr.	grain
gr., gro.	gross
in.	inch
k., kt.	karat
k., kt.	knot
lb.	pound
LT, L.T.	long ton
mi.	mile
mph	miles per hour
n.m.	nautical miles
oz.	ounce
pt.	pint
qt.	quart
sq.	square
rpm	revolutions per minute
T., T	ton
T.	tablespoon in some cookbooks
t.	teaspoon in some cookbooks
tbsp.	tablespoon

tsp.	teaspoon
yd.	yard

Metric Abbreviations

Abbreviation	Unit of Measurement
b	bit
B	byte
C	Celsius, Centigrade
cc or cmi	cubic centimeter (cmi is standard)
cm	centimeter
G,GB	gigabyte (GB is standard)
g, gr	gram (g is standard)
ha	hectare
K	Kelvin
K, KB	kilobyte (KB is standard)
kg	kilogram
kl	kiloliter
km	kilometer
l	liter
m	meter
M, MB	megabyte (MB is standard)
mcg or µg	microgram (µg is standard)
mg	milligram
ml	milliliter
mm	millimeter
MT	metric ton
t, T	metric ton
w, W	watt (W is standard)
kw, kW	kilowatt (kW is standard)
kwh, kWh	kilowatt-hour (kWh is standard)

Task 11. There are some sentences missing in the text (A-H). Put them in the right places (1-8).

A. The residence time of water in each of these cryospheric sub-systems varies widely.

B. However, even a small amount of snow on top of the ice will dramatically reduce the heat flux and slow down the rate of ice growth.

C. Thus, there is a wide overlap with the hydrosphere.

D. The feedback mechanisms involved are often complex and incompletely understood.

E. There are several fundamental physical properties of snow and ice that modulate energy exchanges between the surface and the atmosphere.

F. In terms of areal extent, however, Northern Hemisphere winter snow and ice extent comprise the largest area, amounting to an average 23% of hemispheric surface area in January.

G. (Planetary albedo is determined principally by cloud cover, and by the small amount of total solar radiation received in high latitudes during winter months.)

H. Gutzler and Preston (1997) recently presented evidence for a similar snow-summer circulationfeedback over the southwestern United States.

Cryosphere

The cryosphere (from the Greek κρύος kryos, "cold", "frost" or "ice" and σφαῖρα sphaira, "globe, ball"[) is those portions of Earth's surface where water is in solid form, including sea ice, lake ice, river ice, snow cover,glaciers, ice caps, ice sheets, and frozen ground (which includes permafrost). 1________________________________The cryosphere is an integral part of the global climate system with important linkages andfeedbacks generated through its influence on surface energy and moisture fluxes, clouds, precipitation,hydrology, atmospheric and oceanic circulation. Through these feedback processes, the cryosphere plays a significant role in the global climate and in climate model response to global changes. The term deglaciationdescribes the retreat of cryospheric features.

Frozen water is found on the Earth's surface primarily as snow cover, freshwater ice in lakes and rivers, sea ice,glaciers, ice sheets, and frozen ground and permafrost (permanently frozen ground). 2_________________________________Snow cover and freshwater ice are essentially seasonal, and most sea ice, except for ice in the central Arctic, lasts only a few years if it is not seasonal. A given water particle in glaciers, ice sheets, or ground ice, however, may remain frozen for 10-100,000 years or longer, and deep ice in parts of East Antarctica may have an age approaching 1 million years.

Most of the world's ice volume is in Antarctica, principally in the East Antarctic Ice Sheet. 3____The large areal extent and the important climatic roles ofsnow and ice, related to their unique physical properties, indicate that the ability to observe and model snow and ice-cover extent, thickness, and physical properties (radiative and thermal properties) is of particular significance for climate research.

4 ____ The most important properties are the surface reflectance (albedo), the ability to transfer heat (thermal diffusivity), and the ability to change state (latent heat). These physical properties, together with surface roughness, emissivity, and dielectric characteristics, have important implications for observing snow and ice from space. For example, surface roughness is often the dominant factor determining the strength of radar backscatter . Physical properties such as crystal structure, density, length, and liquid water content are important factors affecting the transfers of heat and water and the scattering of microwaveenergy.

The surface reflectance of incoming solar radiation is important for the surface energy balance (SEB). It is the ratio of reflected to incident solar radiation, commonly referred to as albedo. Climatologists are primarily interested in albedo integrated over the shortwave portion of the electromagnetic spectrum (~300 to 3500 nm), which coincides with the main solar energy input. Typically, albedo values for non-melting snow-covered surfaces are high (~80-90%) except in the case of forests. The higher albedos for snow and ice cause rapid shifts in surface reflectivity in autumn and spring in high latitudes, but the overall climatic significance of this increase is spatially and temporally modulated by cloud cover. 5____Summer and autumn are times of high-average cloudiness over the Arctic Ocean so the albedo feedback associated with the large seasonal changes in sea-ice extent is greatly reduced. Groisman et al. (1994a) observed that snow cover exhibited the greatest influence on the Earth radiative balance in the spring (April to May) period when incoming solar radiation was greatest over snow-covered areas.

The thermal properties of cryospheric elements also have important climatic consequences. Snow and ice have much lower thermal diffusivities than air. Thermal diffusivity is a measure of the speed at which temperature waves can penetrate a substance. Snow and ice are many orders of magnitude less efficient at diffusing heat than air. Snow cover insulates the ground surface, and sea ice insulates the underlying ocean, decoupling the surface-atmosphere interface with respect to both heat and moisture fluxes. The flux of moisture from a water surface is eliminated by even a thin skin of ice, whereas the flux of heat through thin ice continues to be substantial until it attains a thickness in excess of 30 to 40 cm. 6___________________________________The insulating effect of snow also has major implications for the hydrological cycle. In non-permafrost regions, the insulating effect of snow is such that only near-surface ground freezes and deep-water drainage is uninterrupted.

While snow and ice act to insulate the surface from large energy losses in winter, they also act to retard warming in the spring and summer because of the large amount of energy required to melt ice (the latent heat of fusion, 3.34×10^5 J/kg at 0 °C). However, the strong static stability of the atmosphere over areas of extensive snow or ice tends to confine the immediate cooling effect to a relatively shallow layer, so that associated atmospheric anomalies are usually short-lived and local to regional in scale. In some areas of the world such as Eurasia, however, the cooling associated with a heavy snowpack and moist spring soils is known to play a role in modulating the summer monsoon circulation. 7 ______________________________

The role of snow cover in modulating the monsoon is just one example of a short-term cryosphere-climate feedback involving the land surface and the atmosphere. From Figure 1 it can be seen that there are numerous cryosphere-climate feedbacks in the global climate system. These operate over a wide range of spatial and temporal scales from local seasonal cooling of air temperatures to hemispheric-scale variations in ice sheets over time-scales of thousands of years. The 8 ________________________________ For example, Curry et al. (1995) showed that the so-called "simple" sea ice-albedo feedback involved complex interactions with lead fraction, melt ponds, ice thickness, snow cover, and sea-ice extent.

Task 12. Choose one of the texts below. Translate the text and retell it in English to your fellow-students:

1. Snow

Snow cover has the second-largest areal extent of any component of the cryosphere, with a mean maximum areal extent of approximately 47 million km². Most of the Earth's snow-covered area (SCA) is located in the Northern Hemisphere, and temporal variability is dominated by the seasonal cycle; Northern Hemispheresnow-cover extent ranges from 46.5 million km² in January to 3.8 million km² in August. North American winter SCA has exhibited an increasing trend over much of this century (Brown and Goodison 1996; Hughes et al. 1996) largely in response to an increase in precipitation. However, the available satellite data show that the hemispheric winter snow cover has exhibited little interannual variability over the 1972-1996 period, with a coefficient of variation (COV=s.d./mean) for JanuaryNorthern Hemisphere snow cover of < 0.04. According to Groisman et al. (1994a) Northern Hemisphere spring snow cover should exhibit a decreasing trend to explain an observed increase in Northern Hemisphere spring air temperatures this century. Preliminary estimates of SCA from historical and reconstructed in situsnow-cover data suggest this is the case for Eurasia, but not for North America, where spring snow cover has remained close to current levels over most of this century. Because of the close relationship observed between hemispheric air temperature and snow-cover extent over the period of satellite data (IPCC 1996), there is considerable interest in monitoring Northern Hemisphere snow-cover extent for detecting and monitoring climate change.

Snow cover is an extremely important storage component in the water balance, especially seasonal snowpacks in mountainous areas of the world. Though limited in extent, seasonal snowpacks in the Earth's mountain ranges account for the major source of the runoff for stream flow and groundwater recharge over wide areas of the midlatitudes. For example, over 85% of the annual runoff from the Colorado River basin originates as snowmelt. Snowmelt runoff from the Earth's mountains fills the rivers and recharges the aquifers that over a billion people depend on for their water resources. Further, over 40% of the world's protected areas are in mountains, attesting to their value both as unique ecosystems needing protection and as recreation areas for humans. Climate warming is expected to result in major changes to the partitioning of snow and rainfall, and to the timing of snowmelt, which will have important implications for water use and management. These changes also involve potentially important decadal and longer time-scale feedbacks to the climate system through temporal and spatial changes in soil moisture and runoff to the oceans.(Walsh 1995). Freshwater fluxes from the snow cover into the marine environment may be important, as the total flux is probably of the same magnitude as desalinated ridging and rubble areas of sea ice. In addition, there is an associated pulse of precipitated pollutants which accumulate over the Arctic winter in snowfall and are released into the ocean upon ablation of the sea-ice .

2. Sea ice

Sea ice covers much of the polar oceans and forms by freezing of sea water. Satellite data since the early 1970s reveal considerable seasonal, regional, and interannual variability in the sea-ice covers of both hemispheres. Seasonally, sea-ice extent in the Southern Hemisphere varies by a factor of 5, from a minimum of 3-4 million km² in February to a maximum of 17-20 million km² in September.[12][13] The seasonal variation is much less in the Northern Hemisphere where the confined nature and high latitudes of the Arctic Ocean result in a much larger peren- nial ice cover, and the surrounding land limits the equatorward extent of wintertime ice. Thus, the seasonal variability in Northern Hemisphere ice extent varies by only a factor of 2, from a minimum of 7-9 million km² in September to a maximum of 14-16 million km² in March.

The ice cover exhibits much greater regional-scale interannual variability than it does hemispherical. For instance, in the region of the Sea of Okhotsk and Japan, maximum ice extent decreased from 1.3 million km² in 1983 to 0.85 million km² in 1984, a decrease of 35%, before rebounding the following year to 1.2 million km² . The regional fluctuations in both hemispheres are such that for any several-year period of the satellite record some regions exhibit decreasing ice coverage while others exhibit increasing ice cover. The overall trend indicated in the passive microwave record from 1978 through mid-1995 shows that the extent of Arctic sea ice is decreasing 2.7% per decade.[Subsequent work with the satellite passive-microwave data indicates that from late October 1978 through the end of 1996 the extent of Arctic sea ice decreased by 2.9% per decade while the extent of Antarctic sea ice increased by 1.3% per decade. The Intergovernmental Panel on Climate Change publication Climate change 2013: The Physical Science Basis stated that sea ice extent for the Northern Hemisphere showed a decrease of 3.8% ± 0.3% per decade from November 1978 to December 2012.

Lake ice and river ice

Ice forms on rivers and lakes in response to seasonal cooling. The sizes of the ice bodies involved are too small to exert other than localized climatic effects. However, the freeze-up/break-up processes respond to large-scale and local weather factors, such that considerable interannual variability exists in the dates of appearance and disappearance of the ice. Long series of lake-ice observations can serve as a proxy climate record, and the monitoring of freeze-up and break-up trends may provide a convenient integrated and seasonally specific index of climatic perturbations. Information on river-ice conditions is less useful as a climatic proxy because ice formation is strongly dependent on river-flow regime, which is affected by precipitation, snow melt, and watershed runoff as well as being subject to human interference that directly modifies channel flow, or that indirectly affects the runoff via land-use practices.

Lake freeze-up depends on the heat storage in the lake and therefore on its depth, the rate and temperature of any inflow, and water-air energy fluxes. Information on lake depth is often unavailable, although some indication of the depth of shallow lakes in the Arctic can be obtained from airborne radar imagery during late winter (Sellman et al. 1975) and spaceborne optical imagery during summer (Duguay and Lafleur 1997). The timing of breakup is modified by snow depth on the ice as well as by ice thickness and freshwater inflow.

3. Frozen ground and permafrost

Frozen ground (permafrost and seasonally frozen ground) occupies approximately 54 million km² of the exposed land areas of the Northern Hemisphere (Zhang et al., 2003) and therefore has the largest areal extent of any component of the cryosphere. Permafrost (perennially frozen ground) may occur where mean annual air temperatures (MAAT) are less than -1 or -2 °C and is generally continuous where MAAT are less than -7 °C. In addition, its extent and thickness are affected by ground moisture content, vegetation cover, winter snow depth, and aspect. The global extent of permafrost is still not completely known, but it underlies approximately 20% of Northern Hemisphere land areas. Thicknesses exceed 600 m along the Arctic coast of northeastern Siberia and Alaska, but, toward the margins, permafrost becomes thinner and horizontally discontinuous. The marginal zones will be more immediately subject to any melting caused by a warming trend. Most of the presently existing permafrost formed during previous colder conditions and is therefore relic. However, permafrost may form under present-day polar climates where glaciers retreat or land emergence exposes unfrozen ground. Washburn (1973) concluded that most continuous permafrost is in balance with the present climate at its upper surface, but changes at the base depend on the present climate and geothermal heat flow; in contrast, most discontinuous permafrost is probably unstable or "in such delicate equilibrium that the slightest climatic or surface change will have drastic disequilibrium effects".

Under warming conditions, the increasing depth of the summer active layer has significant impacts on the hydrologic and geomorphic regimes. Thawing and retreat of permafrost have been reported in the upper Mackenzie Valley and along the southern margin of its occurrence in Manitoba, but such observations are not readily quantified and generalized. Based on average latitudinal gradients of air temperature, an average northward displacement of the southern permafrost boundary by 50-to-150 km could be expected, under equilibrium conditions, for a 1 °C warming.

Only a fraction of the permafrost zone consists of actual ground ice. The remainder (dry permafrost) is simply soil or rock at subfreezing temperatures. The ice volume is generally greatest in the uppermost permafrost layers and mainly comprises pore and segregated ice in Earth material. Measurements of bore-hole temperatures in permafrost can be used as indicators of net changes in temperature regime. Gold and Lachenbruch (1973) infer a 2-4 °C warming over 75 to 100 years at Cape Thompson, Alaska, where the upper 25% of the 400-m thick permafrost is unstable with respect to an equilibrium profile of temperature with depth (for the present mean annual surface temperature of -5 °C). Maritime influences may have biased this estimate, however. At Prudhoe Bay similar data imply a 1.8 °C warming over the last 100 years (Lachenbruch et al. 1982). Further complications may be introduced by changes in snow-cover depths and the natural or artificial disturbance of the surface vegetation.

The potential rates of permafrost thawing have been established by Osterkamp (1984) to be two centuries or less for 25-meter-thick permafrost in the discontinuous zone of interior Alaska, assuming warming from -0.4 to 0 °C in 3–4 years, followed by a further 2.6 °C rise. Although the response of permafrost (depth) to temperature change is typically a very slow process (Osterkamp 1984; Koster 1993), there is ample evidence for the fact that the active layer thickness quickly responds to a temperature change (Kane et al. 1991). Whether, under a warming or cooling scenario, global climate change will have a significant effect on the duration of frost-free periods in both regions with seasonally and perennially frozen ground.

4. Glaciers and ice sheets

Ice sheets and glaciers are flowing ice masses that rest on solid land. They are controlled by snow accumulation, surface and basal melt, calving into surrounding oceans or lakes and internal dynamics. The latter results from gravity-driven creep flow ("glacial flow") within the ice body and sliding on the underlying land, which leads to thinning and horizontal spreading. Any imbalance of this dynamic equilibrium between mass gain, loss and transport due to flow results in either growing or shrinking ice bodies.

Ice sheets are the greatest potential source of global freshwater, holding approximately 77% of the global total. This corresponds to 80 m of world sea-level equivalent, with Antarctica accounting for 90% of this. Greenland accounts for most of the remaining 10%, with other ice bodies and glaciers accounting for less than 0.5%. Because of their size in relation to annual rates of snow accumulation and melt, the residence time of water in ice sheets can extend to 100,000 or 1 million years. Consequently, any climatic perturbations produce slow responses, occurring over glacial and interglacial periods. Valley glaciers respond rapidly to climatic fluctuations with typical response times of 10–50 years. However, the response of individual glaciers may be asynchronous to the same climatic forcing because of differences in glacier length, elevation, slope, and speed of motion. Oerlemans (1994) provided evidence of coherent global glacier retreat which could be explained by a linear warming trend of 0.66 °C per 100 years.[21]

While glacier variations are likely to have minimal effects upon global climate, their recession may have contributed one third to one half of the observed 20th Century rise in sea level (Meier 1984; IPCC 1996). Furthermore, it is extremely likely that such extensive glacier recession as is currently observed in the Western Cordillera of North America,[22] where runoff from glacierized basins is used for irrigation and hydropower, involves significant hydrological and ecosystem impacts. Effective water-resource planning and impact mitigation in such areas depends upon developing a sophisticated knowledge of the status of glacier ice and the mechanisms that cause it to change. Furthermore, a clear understanding of the mechanisms at work is crucial to interpreting the global-change signals that are contained in the time series of glacier mass balance records.

Combined glacier mass balance estimates of the large ice sheets carry an uncertainty of about 20%. Studies based on estimated snowfall and mass output tend to indicate that the ice sheets are near balance or taking some water out of the oceans.[Marinebased studies suggest sea-level rise from the Antarctic or rapid ice-shelf basal melting. Some authors (Paterson 1993; Alley 1997) have suggested that the difference between the observed rate of sea-level rise (roughly 2 mm/y) and the explained rate of sea-level rise from melting of mountain glaciers, thermal expansion of the ocean, etc. (roughly 1 mm/y or less) is similar to the modeled imbalance in the Antarctic (roughly 1 mm/y of sea-level rise; Huybrechts 1990), suggesting a contribution of sea-level rise from the Antarctic.

Relationships between global climate and changes in ice extent are complex. The mass balance of land-based glaciers and ice sheets is determined by the accumulation of snow, mostly in winter, and warm-season ablation due primarily to net radiation and turbulent heat fluxes to melting ice and snow from warm-air advection, (Munro 1990). However, most of Antarctica never experiences surface melting. Where ice masses terminate in the ocean, iceberg calving is the major contributor to mass loss. In this situation, the ice margin may extend out into deep water as a floating ice shelf, such as that in the Ross Sea. Despite the possibility that global warming could result in losses to the Greenland ice sheet being offset by gains to the Antarctic ice sheet, there is major concern about the possibility of a West Antarctic Ice Sheet collapse. The West Antarctic Ice Sheet is grounded on bedrock below sea level, and its collapse has the potential of raising the world sea level 6–7 m over a few hundred years.

Most of the discharge of the West Antarctic Ice Sheet is via the five major ice streams (faster flowing ice) entering the Ross Ice Shelf, the Rutford Ice Streamentering Ronne-Filchner shelf of the Weddell Sea, and the Thwaites Glacier and Pine Island Glacier entering the Amundsen Ice Shelf. Opinions differ as to the present mass balance of these systems (Bentley 1983, 1985), principally because of the limited data. The West Antarctic Ice Sheet is stable so long as the Ross Ice Shelf is constrained by drag along its lateral boundaries and pinned by local grounding.

Task 13. Choose one of the topics to make a report and present it in front of the class.

1. Hydrosphere
2. Cryosphere
3. The role of water in everyday life
4. Water pollution

UNIT 6. ATMOSPHERE

6.1 THE EARTH'S ATMOSPHERE

PRE-READING

Task 1. Complete the table with translations and transcriptions of the words from the text.

Word	Transcription	Traslation
Atmosphere		
Layer		
Sufficient		

Gravity		
Surface		
Liquid		
Solar system		
Invisible		
Account for		
Portion		
Vapor		
Dust		
Spread out		
Barely		
Weight		
Equal		
Entire		
Bottom		
Eject		
Altitude		

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What do you know about the term atmosphere?
2. Is there life on Jupiter, Saturn or other planets of the solar system?
3. Is the Earth moving around the Sun or the sun moving around the Earth?
4. What parts does the atmosphere consist of?
5. Can life exist without oxygen?

TEXT

Task 3. Read, translate the text and be ready to do the exercises.

Atmosphere

An atmosphere (New Latin atmosphaera, 17th century, from Greek ἀτμός [at-mos] "vapor" and σφαῖρα [sphaira] "sphere") is a layer of gases surrounding a planet or other material body of sufficient mass that is held in place by the gravity of the body. An atmosphere is more likely to be retained if the gravity is high and the atmosphere's temperature is low.

Scientists have gathered enough information about other planets in our solar system to know that none can support life as we know it. Life is not possible without a stable atmosphere containing the right chemical ingredients for living organisms: hydrogen, oxygen, nitrogen, and carbon. These ingredients must be balanced: not too thick or too thin. Life also depends on the presence of water.

Jupiter, Saturn, Uranus, and Neptune all have atmospheres made mostly of hydrogen and helium. These planets are called gas giants, because they are mostly made of gas and do not have a solid outer crust.

Mercury and Mars have some of the right ingredients, but their atmospheres are far too thin to support life. The atmosphere of Venus is too thick: the planet’s surface temperature is more than 460 degrees Celsius (860 degrees Fahrenheit).

Jupiters moon Europa has a thin atmosphere rich with oxygen. It is likely covered by a huge ocean of liquid water. Some astrobiologists think that if life will develop elsewhere in the solar system, it will be near vents at the bottom of Europa’s ocean.

We live at the bottom of an invisible ocean called the atmosphere, a layer of gases surrounding our planet. Nitrogen and oxygen account for 99 percent of the gases in dry air, with argon, carbon dioxide, helium, neon, and other gases making up minute portions. Water, vapor and dust are also part of Earth’s atmosphere. Other planets and moons have very different atmospheres, and some have no atmospheres at all.

The atmosphere is so spread out that we barely notice it, yet its weight is equal to a layer of water more than 10 meters (34 feet) deep covering the entire planet. The bottom 30 kilometers (19 miles) of the atmosphere contains about 98 percent of its mass. The atmosphere—air—is much thinner at high altitudes. There is no atmosphere in space.

Scientists say many of the gases in our atmosphere were ejected into the air by early volcanoes. At that time, there would have been little or no free oxygen surrounding the Earth. Free oxygen consists of oxygen molecules not attached to another element, like carbon (to form carbon dioxide) or hydrogen (to form water).

Free oxygen may have been added to the atmosphere by primitive organisms, probably bacteria, during photosynthesis. Photosynthesis is the process a plant or other autotroph uses to make food and oxygen from carbon dioxide and water. Later, more complex forms of plant life added more oxygen to the atmosphere. The oxygen in today’s atmosphere probably took millions of years to accumulate.

The atmosphere acts as a gigantic filter, keeping out most ultraviolet radiation while letting in the sun’s warming rays. Ultraviolet radiation is harmful to living things, and is what causes sunburns. Solar heat, on the other hand, is necessary for all life on Earth.

Earth’s atmosphere has a layered structure. From the ground toward the sky, the layers are the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. Another layer, called the ionosphere, extends from the mesosphere to the exosphere. Beyond the exosphere is outer space. The boundaries between atmospheric layers are not clearly defined, and change depending on latitude and season.

The term stellar atmosphere describes the outer region of a star, and typically includes the portion starting from the opaque photosphere outwards. Stars with sufficiently low temperatures may form compound molecules in their outer atmosphere.

The Earth's atmosphere consists of a number of layers that differ in properties such as composition, temperature and pressure. The lowest layer is the troposphere, which includes the planetary boundary layer or peplosphere at its base. Three quarters of the atmospheric mass resides within the troposphere, and the depth of this layer varies between 17 km at the equator and 7 km at the poles. The stratosphere, from 20 to 50 km, includes the ozone layer, located at altitudes between 15 and 35 km, which absorbs ultraviolet energy from the Sun. The mesosphere, from 50 to 85 km is the layer in which most meteors burn up. The thermosphere extends from 85 km to the base of the exosphere at 690 km and contains the ionosphere, a region where the atmosphere is ionised by incoming solar radiation. The Kármán line, located within the thermosphere at an altitude of 100 km, is commonly used to define the boundary between the Earth's atmosphere and outer space. The exosphere extends from about 690 to 1,000 km above the surface, where it interacts with the planet's magnetosphere. Each of the layers has a different lapse rate, defining the rate of change in temperature with height.

(Retrieved from: https://en.wikipedia.org/wiki/Atmosphere)

Vocabulary

- Hydrogen [ˈhaɪdrədʒən] - водород
- Oxygen [ˈɒksɪdʒən] - кислород
- Nitrogen [ˈnaɪtrədʒən] - азот
- Carbon [ˈkɑːbən] - углерод
- Helium [ˈhiːliəm] – гелий
- Argon [ˈɑːgɒn] – аргон
- Neon [ˈniːɒn]– неон
- Minute portions [maɪˈnjuːt ˈpɔːʃn s] – крошечные количества

Word study

Task 4. Write 5 sentences with the new words. You can use more than 1 new word in each sentence.

Task 5. Use your dictionary to complete the following table.

Verb	Noun	Adjective
		sufficient
	system	
support		
	boundary	
		different
	surroundings	
develop		
	accumulation	

Task 6. Read the names of the chemical elements correctly. Mind the stress, use dictionary if necessary.

Hydrogen
Lithium
Berylium
Helium
Boron
Carbon
Nitrogen
Oxygen
Neon

Sodium
Magnesium
Aluminium
Silicon
Chlorine
Argon
Calcium
Titanium
Chromium

Iron
Cobalt
Nickel
Copper
Zinc
Silver
Platinum
Gold
Lead

Task 7. Match English phrases with their Russian equivalents.

gravity of the body	молекулы кислорода
ultraviolet radiation	атмосфера звезд
solar wind	постоянная атмосфера
cosmic ray	слоистая структура
living organisms	космический луч
stellar atmosphere	гравитация тела
stable atmosphere	живые организмы
solar system	солнечный ветер
oxygen molecules	солнечная система
a layered structure	ультрафиолетовая радиация

Task 8. Fill the missing words in the sentences below.

plants composition atmosphere(2) star living organisms photosynthesis radiation oxygen

The______________ of Earth is mostly composed of nitrogen. It also contains_____________used by most organisms for respiration and carbon diox- ide used by___________________, algae and cyanobacteria for_______________. It pro- tects________organisms from genetic damage by solar ultraviolet____________, solar wind and cosmic rays. Its current____________is the product of billions of years of biochemical modification of the paleoatmosphere by living___________.

The term stellar atmosphere describes the outer region of a________, and typi- cally includes the portion starting from the opaque photosphere outwards. Stars with sufficiently low temperatures may form compound molecules in their outer ____________.

Task 9. Give the English equivalents.

солнечная система	гравитация
живые организмы	тонкий слой
ультрафиолетовая радиация	окружающий планету
атмосфера земли	зависит от наличия воды
фотосинтез	химические элементы

Comprehension and discussion

Task 10. Answer the questions:

1. How can you explain the term atmosphere?
2. What layers does the atmosphere of the Earth consist of?
3. What other planets of the solar system can support life as we know it? Why?
4. What chemical are essencial for livivng?
5. What is the atmosphere of the other planets of the solar system?
6. Is there atmosphere in space?
7. How long did it take to form the present level of oxigen on the Earth?
8. What is photosynthesis?
9. The term stellar atmosphere describes the outer region of a star,

doesn’t it?

10. Which is the most distant layer of the atmosphere?

Task 11. Complete the following sentences:

1. An atmosphere is a layer of gases...
2. Life is not possible without a stable atmosphere containing...
3. Jupiter, Saturn, Uranus, and Neptune all have atmospheres made mostly of...
4. Scientists say many of the gases in our atmosphere...
5. Photosynthesis is...
6. From the ground toward the sky, the layers of the Earth are...
7. Ionosphere, extends from... to...
8. The Earth's atmosphere consists of a number of layers that differ in properties such as...

Task 12. Speak on.

1. The atmospere of the Earth.
2. The atmospere of the other planets of the solar system.
3. The layers of the atmospere of the Earth.

Task 13. Translate the text and retell it in English:

Troposphere

The troposphere is the lowest atmospheric layer. On average, the troposphere extends from the ground to about 10 kilometers (6 miles) high, ranging from about 6 kilometers (4 miles) at the poles to more than 16 kilometers (10 miles) at the Equator. The top of the troposphere is higher in summer than in winter.

Almost all weather develops in the troposphere because it contains almost all of the atmosphere’s water vapor. Clouds, from low-lying fog to thunderheads to high-altitude cirrus, form in the troposphere. Air masses, areas of high-pressure and low-pressure systems, are moved by winds in the troposphere. These weather systems lead to daily weather changes as well as seasonal weather patterns and climate systems, such as El Nino.

Air in the troposphere thins as altitude increases. There are fewer molecules of oxygen at the top of Mount Everest, Nepal, for example, than there are on a beach in Hawaii. This is why mountaineers often use canisters of oxygen when climbing tall peaks. Thin air is also why helicopters have difficulty maneuvering at high altitudes. In fact, a helicopter was not able to land on Mount Everest until 2005.

As air in the troposphere thins, temperature decreases. This is why mountaintops are usually much colder than the valleys beneath. Scientists used to think temperature continued to drop as altitude increased beyond the troposphere. But data collected with weather balloons and rockets have showed this is not the case.

In the lower stratosphere, temperature stays almost constant. As altitude increases in the stratosphere, temperature actually increases.

Solar heat penetrates the troposphere easily. This layer also absorbs heat that is reflected back from the ground in a process called the greenhouse effect. The greenhouse effect is necessary for life on Earth. The atmosphere's most abundant greenhouse gases are carbon dioxide, water vapor, and methane.

Fast-moving, high-altitude winds called jet streams swirl around the planet near the upper boundary of the troposphere. Jet streams are extremely important to the airline industry. Aircraft save time and money by flying in jet streams instead of the lower troposphere, where air is thicker.

Task 14. Render this text in English:

Атмосфера — газовая оболочка небесного тела, удерживаемая около него гравитацией. Поскольку не существует резкой границы между атмосферой и межпланетным пространством, то обычно атмосферой принято считать область вокруг небесного тела, в которой газовая среда вращается вместе с ним как единое целое. Глубина атмосферы некоторых планет, состоящих в основном из газов (газовые планеты), может быть очень большой.

Атмосфера Земли содержит кислород, используемый большинством живых организмов для дыхания, и диоксид углерода, потребляемый растениями, водорослями и бактериями в процессе фотосинтеза. Атмосфера также является защитным слоем планеты, защищая её обитателей от солнечного ультрафиолетового излучения.

Атмосфера есть у всех массивных тел — планет земного типа, газовых гигантов.

Task 15. Put the verbs into the right form. Explain your choice and comment on the use of Present Simple Tense.

Stratosphere

The troposphere (to tend) to change suddenly and violently, but the stratosphere ________ (to be) calm. The stratosphere_______(to extend) from the tropopause, the upper boundary of the troposphere, to about 50 kilometers (32 miles) above the

Earth’s surface. Strong horizontal winds_____ (to blow) in the stratosphere, but there (to be) little turbulence. This_ (is) ideal for planes that can fly in this part of the atmosphere.

The stratosphere _____ (to be) very dry and clouds _____ (to be) rare. Those that

_______ (to form)_____(to be) thin and wispy. They_______(to be called) nacreous clouds. Sometimes they____________(to be called) mother-of-pearl clouds because their colors _______ (to look) like those inside a mollusk shell.

The stratosphere_______(to be) crucial to life on Earth because it_ (to contain) small amounts of ozone, a form of oxygen that____________(to prevent) harmful UV rays from reaching Earth. The region within the stratosphere where this thin shell of ozone is found________(to be called) the ozone layer. The stratosphere's ozone layer _______ (to be) uneven, and thinner near the poles. The amount of ozone in the Earth's atmosphere__________(to decline) steadily. Scientists________(to link) use of chemicals such as chlorofluorocarbons (CFCs) to ozone depletion.

6.2 EXTRATERRESTRIAL ATMOSPHERES

PRE-READING

Task 1. Complete the table with translations and transcriptions of the words from the text.

word	transcription	traslation
terrestrial		
giant		
hydrogen		
to dominate		
helium		
oxygen		
carbon		
acid		
sulphur		
methane		
band		
cyclone		
celestial		
exploration		

Task 2. Before reading the passage, answer all the following questions and discuss it with your partner. Then read the passage and find the facts supporting your ideas.

1. What planets of the solar system do you know?

2. How can these planets be divided into two groups?

3. Do you believe in life on another planets?

4. Can you imagine the appearance of the aliens?

5. What movies tell us about life on other planets?

6. **TEXT**

Task 3. Read, translate the text and be ready to do the exercises.

Extraterrestrial Atmospheres

All the planets in our solar system have atmospheres. Most of these atmospheres are radically different from Earth’s, although they contain many of the same elements.

The solar system has two major types of planets: terrestrial planets (Mercury, Venus, Earth, and Mars) and gas giants (Jupiter, Saturn, Uranus, and Neptune).

The atmospheres of the terrestrial planets are somewhat similar to Earth’s. Mercury’s atmosphere contains only a thin exosphere dominated by hydrogen, helium, and oxygen. Venus’ atmosphere is much thicker than Earth’s, preventing a clear view of the planet. Its atmosphere is dominated by carbon dioxide, and features swirling clouds of sulfuric acid. The atmosphere on Mars is also dominated by carbon dioxide, although unlike Venus, it is quite thin.

Gas giants are composed of gases. Their atmospheres are almost entirely hydrogen and helium. The presence of methane in the atmospheres of Uranus and Neptune give the planets their bright blue color.

In the lower atmospheres of Jupiter and Saturn, clouds of water, ammonia, and hydrogen sulfide form clear bands. Fast winds separate light-colored bands, called zones, from dark-colored bands, called belts. Other weather phenomena, such as cyclones and lightning, create patterns in the zones and belts. Jupiter’s Great Red Spot is a centuries-old cyclone that is the largest storm in the solar system.

The moons of some planets have their own atmospheres. Saturn’s largest moon, Titan, has a thick atmosphere made mostly of nitrogen and methane. The way sunlight breaks up methane in Titan’s ionosphere helps give the moon an orange color.

Most celestial bodies, including all the asteroids in the asteroid belt and our own moon, do not have atmospheres. The lack of an atmosphere on the Moon means it does not experience weather. With no wind or water to erode them, many craters on the Moon have been there for hundreds and even thousands of years.

The way a celestial body’s atmosphere is structured and what it’s made of allow astrobiologists to speculate what kind of life the planet or moon may be able to support. Atmospheres, then, are important markers in space exploration.

A planet or moon's atmosphere must contain specific chemicals to support life as we know it. These chemicals include hydrogen, oxygen, nitrogen, and carbon. Although Venus, Mars, and Titan have similar atmospheric gases, there is nowhere in the solar system besides Earth with an atmosphere able to support life. Venus' atmosphere is far too thick, Mars' far too thin, and Titan's far too cold.

(Retrieved from: https://en.wikipedia.org/wiki/Extraterrestrial_atmospheres)

Vocabulary

- Mercury [ˈmɜːkjəri] - Меркурий
- Venus [ˈviːnəs] - Венера
- Earth [ɜːθ] - Земля
- Mars [mɑːz] - Марс
- Jupiter [ˈdʒuːpɪtə(r)] - Юпитер
- Saturn [ˈsætɜːn], [ˈsætən] - Сатурн
- Uranus [ˈjʊərənəs] - Уран
- Neptune [ˈneptjuːn] – Нептун

Word study

Task 4. Write 5 sentences with the new words. You can use more than 1 new word in each sentence.

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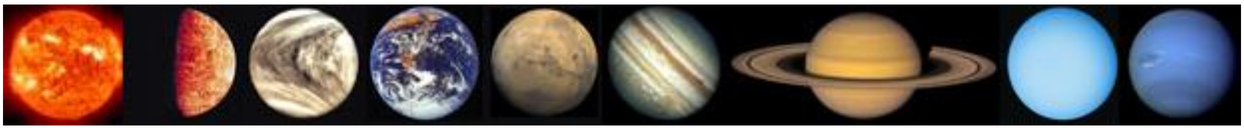
Task 5. In the text we find: “Saturn’s largest moon...” **Complete the following sentences using the right degree of comparison.**

1. No other boy is as..................................as James. (tall / taller / tallest)
2. Milk is ………………….. than any other food. (nourishing / more nourishing / most nourishing)
3. Radium is one of the ……………………… metals. (valuable / more valuable / most valuable)
4. Few English poets were as …………………… as Wordsworth. (great / greater / greatest)
5. Shimla is................................than most other hill stations in India. (famous / more famous / most famous)
6. Gold is one of the …………………… metals. (precious / more precious / most precious)
7. Solomon was .... than any other king. (wise / wiser / wisest)
8. Few historians write as............................... as Macaulay. (well / better /best)
9. Very few books are as..................................as David Copperfield. (popular / more popular / most popular)
10. A train is .... than a car. (fast / faster / fastest)

Task 6. Put the names of the planets into the right order.

Venus, the Sun, Earth, Jupiter, Neptune, Mercury, Mars, Saturn, Uranus



Task 7. Give the English equivalents:

1. газовый гигант;
2. атмосфера земли;
3. поддерживать жизнь;
4. небесное светило;
5. пояс астероидов;
6. солнечный свет;
7. оранжевый цвет;
8. сульфид углерода;
9. двуокись углерода;
10. серная кислота.

Task 8. Choose the best variant and complete the gaps.

1. Pigeons can use the _____________ magnetic field to find their way home.
a. planet
b. terrestrial
c. land

2. Trees give off oxygen and absorb___________dioxide.
a. carbon
b. sulphur
c. acid

3. A common theme____________the discussions was that of funding shortfalls and their implications for refugee and returnee programmes in Africa.
a. dominated
b. is dominating
c. dominating

4. The girl at the counter had adverted that they had run out of small cars and that they had to give us that_________car.
a. giant
b. more giant
c. most giant

5. Vitamin C is also known as ascorbic_________.
a. acid
b. asid
c. acit

6. Uranus' atmosphere is made up of hydrogen, _________, and methane.
a. oxigen
b. helium
c. water

7. A number of these same areas are chronically prone to natural disasters, including drought,___________, earthquakes and hurricanes.
a. watering
b. cyclones
c. cycles

Exercise 9. Give as many synonyms to the word as you can.

a. major
b. contain

c. presence
d. similar
e. are composed
f. phenomena

Task 10. Make up sentences – mind the word order.

1. planets \ solar \ atmospheres \ all \ in \ system \ the \ our \ have
2. Earth’s \ to \ similar \ somewhat \ are \ planets \ terrestial \ the \ of \ atmospheres \ the
3. the \ system \ two \ types \ planets \ planets \ gas \ solar \ has \ major \ of \ terrestrial \ and \ giants.
4. of \ gases \ gas \ composed \ giants \ are
5. Atmospheres \ planets \ the \ moons \ have \ own \ of \ their \ some
6. markers are space in atmospheres important exploration
7. or \ must \ chemicals \ life \ a \ moon’s \ contain \ to \ planet \ atmosphere \ specific \ support
8. Oxygen \ carbon \ include \ nitrogen \ and \ these \ hydrogen \ chemicals

Comprehension and discussion

Task 11. Answer the questions.

1. Which objects contain atmospheres?
2. Are the atmospheres of the planets of our solar system different from the Earth’s?
3. How many types of planets does the solar system have?
4. Which planets are called terrestrial?
5. Which planets are gas giants?
6. What do you know about the atmospheres of Mercury and Venus?
7. What is different and alike in the atmospheres of Venus and Mars?
8. What elements mainly form the atmospheres of gas giants?
9. Does methane give bright blue color to the atmospheres of Uranus and Neptune?
10. What is the largest storm in the solar system?
11. Do moons of the planets have thoer own atmospheres?
12. What space bodies do not have atmospheres?
13. Which elements are essencial to support life as we know it?

Task 12. Choose one of the topics to make a report and present it in front of the class.

1. Terrestrial planets
2. Gas giants
3. The planets of the solar system
4. The life-supporting role of the atmosphere

Task 13. Render this text in English:

Химия атмосферы. Из каких газов состоит атмосфера

Наша атмосфера - оболочка, состоящая из нескольких основных слоёв, общая толщина которых превышает 1000 км. Между слоями не существут чётких границ. В порядке удаления от поверхности Земли в состав атмосферы входят: тропосфера (около 11...12 км), стратосфера (до 45...50 км), мезосфера (до 85...95 км), термосфера (до 600...700 км), экзосфера (выше 800 км). С увеличением высоты падает давление находящихся в атмосфере газов (увеличивается разряжение). Основная часть воздуха, конечно же, сосредоточена в ближних слоях атмосферы. Сухой воздух является смесью газов и имеет ледующую пропорцию по объёму: азот (78,095%), кислород (20,939%), углекислый газ (0,031%), инертные газы (гелий, неон, криптон, ксенон, аргон - 0,935%), из которых аргон составляет 0,933%.

Task 14. Choose one of the texts above. Translate the text and retell it in English to your fellow-students:

1. Mesosphere

The mesosphere extends from the stratopause (the upper boundary of the stratosphere) to about 85 kilometers (53 miles) above the surface of the Earth. Here, temperatures again begin to fall. The mesosphere has the coldest temperatures in the atmosphere, dipping as low as -120 degrees Celsius (-184 degrees Fahrenheit, or 153 kelvin). The mesosphere also has the atmosphere’s highest clouds. In clear weather, you can sometimes see them as silvery wisps immediately after sunset. They are called noctilucent clouds, or night-shining clouds. The mesosphere is so cold that noctilucent clouds are actually frozen water vapor—ice clouds. Shooting stars—the fiery burnout of meteors, dust, and rocks from outer space—are visible in the mesosphere. Most shooting stars are the size of a grain of sand and burn up before entering the stratosphere or troposphere. However, some meteors are the size of pebbles or even boulders. Their outer layers burn as they race through the mesosphere, but they are massive enough to fall through the lower atmosphere and crash to Earth as meteorites. The mesosphere is the least-understood part of Earth's atmosphere. It is too high for aircraft or weather balloons to operate, but too low for spacecraft. Sounding rockets have provided meteorologists and astronomers their onlysignificant data on this important part of the atmosphere. Sounding rockets are unmanned research instruments that collect data during sub-orbital flights. Perhaps because the mesosphere is so little understood, it is home to two meteorological mysteries: sprites andelves. Sprites are reddish, vertical electrical discharges that appear high above thunderheads, in the upper stratosphere and mesosphere. Elves are dim, halo-shaped discharges that appear even higher in the mesosphere.

2. Ionosphere

The ionosphere extends from the top half of the mesosphere all the way to the exosphere. This atmospheric layer conducts electricity. The ionosphere is named for ions created by energetic particles from sunlight and outer space. Ions are atoms in which the number of electrons does not equal the number of protons, giving the atom a positive (fewer electrons than protons) or negative (more electrons than protons) charge. Ions are created as powerful x-rays and UV rays knock electrons off atoms.

The ionosphere—a layer of free electrons and ions—reflects radio waves. Guglielmo Marconi, the "Father of Wireless," helped prove this in 1901 when he sent a radio signal from Cornwall, England, to St. John's, Newfoundland, Canada. Marconi's experiment demonstrated that radio signals did not travel in a straight line, but bounced off an atmospheric layer—the ionosphere.

The ionosphere is broken into distinct layers, called the D, E, F1, and F2 layers. Like all other parts of the atmosphere, these layers vary with season and latitude. Changes in the ionosphere actually happen on a daily basis. The low D layer, which absorbs high-frequency radio waves, and the E layer actually disappear at night, which means radio waves can reach higher into the ionosphere. That's why AM radio stations can extend their range by hundreds of kilometers every night.

The ionosphere also reflects particles from solar wind, the stream of highly charged particles ejected by the sun. These electrical displays create auroras (light displays) called the Northern and Southern Lights.

3. Thermosphere

The thermosphere is the thickest layer in the atmosphere. Only the lightest gases—mostly oxygen, helium, and hydrogen—are found here.

The thermosphere extends from the mesopause (the upper boundary of the mesosphere) to 690 kilometers (429 miles) above the surface of the Earth. Here, thinly scattered molecules of gas absorb x-rays and ultraviolet radiation. This absorption process propels the molecules in the thermosphere to great speeds and high temperatures. Temperatures in the thermosphere can rise to 1,500 degrees Celsius (2,732 degrees Fahrenheit, or 1,773 kelvin). Though the temperature is very high, there is not much heat. How is that possible? Heat is created when molecules get excited and transfer energy from onemolecule to another. Heat happens in an area of high pressure (think of water boiling in a pot). Since there is very little pressure in the thermosphere, there is little heat transfer.

The Hubble Space Telescope and the International Space Station (ISS) orbit the Earth in the thermosphere. Even though the thermosphere is the second-highest layer of Earth's atmosphere, satellites that operate here are in "low-Earth orbit."

Task 15. Put the verbs into the right form. Explain your choice and comment on the use of Passive Voice.

Exosphere

The fluctuating area between the thermosphere and the exosphere_________(to call) the turbopause. The lowest level of the exosphere _____________ (to call) the exobase. At the upper boundary of the exosphere, the ionosphere ____________ (to merge) with interplanetary space, or the space between planets. The exosphere _______ (to expand) and _______ (to contrast) as it ________ (to come) into contact with solar storms. In solar storms particles_______________(to fling) through space from explosive events on the sun, such as solar flares and coronal mass ejections (CMEs). Solar storms can squeeze the exosphere to just 1,000 kilometers (620 miles) above the Earth. When the sun__________(to be) calm, the exosphere can extend 10,000 kilometers (6,214 miles). Hydrogen, the lightest element in the universe,___________(to dominate) the thin atmosphere of the exosphere. Only trace amounts of helium, carbon dioxide, oxygen, and other gases_________(to be) present. Many weather satellites orbit Earth in the exosphere. The lower part of the exosphere _____________ (to include) low-Earth orbit, while medium-Earth orbit is higher in the atmosphere. The upper boundary of the exosphere____________(to be) visible in satellite images of Earth. Called the geocorona, it _______ (to be) the fuzzy blue illumination that _________ (to circle) the Earth.

Part II. Supplementary reading

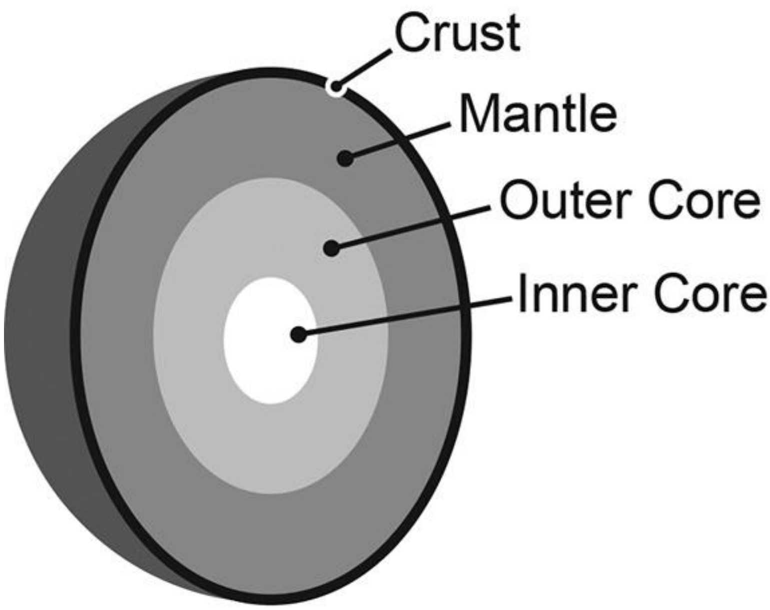
Text 1. Planet Earth

Our planet is about 4.5 billion years old. Situated 150 million kilometres away from the Sun, it has a circumference of about 30,800 kilometres. It is almost spherical, but bulges a little at the equator and it is flattened slightly at the North and South poles.

The Earth has an inner core, which makes up about 16 per cent of its total volume, and an outer mantle. The core consists mainly of molten iron at a temperature of around 2,500°C, although there appears to be a solid part right at the centre. The mantle is about 2,900 kilometres thick and consists of relatively solid rock.

Outside the mantle there is a relatively thin layer of less dense rock called the crust. The average thickness of the crust is 35 kilometres on land and 5–6 kilometres under the oceans. The highest point on the Earth's crust, Mount Everest, is nearly 19 kilometres above the lowest point, which is in the ocean just off the coast of the Philippines.

Ninety-eight per cent of the solid matter of the Earth's crust is made up of eight elements. These, in order of abundance, are oxygen, silicon, aluminium, iron, calcium, sodium, potassium and magnesium. Oxygen accounts for 94 per cent of the crust by volume and 47 per cent by weight, and silicon accounts for 1 per cent of the crust by volume and 28 per cent by weight.



There are three broad classes of rock in the Earth's crust. First, there is the original igneous rock, which was formed when the hot molten liquid of the Earth's core cooled and solidified. Basalt, obsidian and granite are examples of igneous rock. Second, there is sedimentary rock, which was formed by pressure or a chemical cementing action on rock fragments. Examples of sedimentary rock include sandstone and shale.

The third main category is metamorphic rock, in which the original structure has been altered by the action of heat, pressure or chemicals. Examples of metamorphic rock include schist, slate and marble.

As a result of physical and chemical weathering, some of the rock of the crust is broken up, forming a layer of particles of disintegrated rock of different sizes, like gravel, sand and clay.

The Earth's crust is coated with an envelope of gases — the atmosphere. Apart from water vapour, the main permanent gases in the atmosphere are nitrogen (78 per cent), oxygen (21 per cent), argon (0.93 per cent) and carbon dioxide (0.04 per cent and increasing).

Another key component of the planet's surface is water, around 97 per cent of which is in the oceans. About 2 per cent of the Earth's surface water is in the form of ice or snow in the polar regions, and about 0.5 to 1.5 per cent in the soil and in cracks between rocks. Less than 0.03 per cent is in ponds, streams, rivers and lakes, while only about 0.001 per cent is in the atmosphere.

The surface of the Earth receives constant radiation of energy from the Sun, where it is generated by nuclear fusion. This input of energy is in the form of the shorter wavelength ultraviolet rays, through visible light, to infrared. It is eventually re-radiated back into space, mainly in the form of heat.

The energy from the Sun is largely responsible for the two great circulatory systems on the Earth's surface — those of the atmosphere and the oceans. The flows in the atmosphere are caused by the unequal heating of large masses of air, and this leads to air movements that then set in motion the flows of water in the surface layers of the oceans. The patterns of flow in both the atmosphere and the oceans are also affected by the rotational movement of the planet. This is known as the Coriolis effect. The end result is that heat becomes more evenly spread over the surface of the planet.

Another important process that is driven partly by the energy from the Sun, but also by gravity, is the water cycle. Heat from the Sun causes water to evaporate from the surfaces of the oceans, lakes and land to form water vapour in the atmosphere. When this vapour cools, the water condenses and gravity eventually causes the droplets to fall back to Earth as rain or snow. Gravity also plays an essential role by causing much of the water that falls on land to sink down into the soil and then move into streams and rivers, from where it eventually flows back into the oceans.

Certain of the gases in the atmosphere, notably water vapour and, to a lesser extent, carbon dioxide, play a key role in keeping the temperature of the Earth's surface at levels suitable for life as we know it. The end result of this process, which is referred to as the greenhouse effect, is a world with an average temperature of around around 15°C. If these gases were not there, the energy radiated onto the Earth's surface from the Sun would re-radiate back into space, mainly in the form of heat, and the average temperature of the Earth would be –18°C.

(Retrieved from http://press-files.anu.edu.au/downloads/press/n1965/html/ch02.xhtml?referer=&page=6)

Text 2. The evolution of life: the first 4 billion years

The earliest living things on Earth are believed to have come into being around 4 billion years ago. They were single-celled organisms and they were the most complex form of life on Earth for approximately a 1 billion years. There were, and still are, two distinct groups of such microorganisms with different biochemical characteristics. They are classified as Bacteria and Archaea. The Archaea include microbes that live and multiply under extreme conditions, such as very high temperatures and very high salinity. It is not known which of these groups came into existence first.

It is believed that the main source of energy for the first single-celled organisms was energy-containing chemical compounds that had formed through the action of ultraviolet (UV) radiation and electrical discharges in storms. But the amount of energy from such sources was strictly limited, and there was certainly not enough of it to sustain life on the scale that exists today.

Single-celled organisms capable of photosynthesis — cyanobacteria — were in existence by around 2.5 billion years ago. This development represents one of the great watersheds in biological evolution. It changed the living world forever. In photosynthesis, light energy from the Sun is captured in the leaves of green plants and converted into chemical energy in the form of complex organic molecules. All animal and plant life on Earth is entirely dependent on this process. Photosynthesis involves the uptake of carbon dioxide and water from the environment and the release of free oxygen.

The emergence of photosynthesis had far-reaching evolutionary consequences. Among these was the fact that oxygen began to accumulate in the atmosphere, making it possible for life forms to evolve that relied on oxygen for their respiratory processes. Another outcome was the fact that some of the atmospheric oxygen was converted to ozone (O_3), which formed a layer in the upper part of the atmosphere. Here, it acted as a filter, absorbing much of the UV radiation from the Sun. As a result, by the time that humans appeared on Earth, and probably by 2 billion years before this, only about half of the total solar UV radiation, and a much smaller fraction of the short-wave UV-B rays, penetrated through to the Earth's surface. Had it not been for this effect, life as it exists on land today would not have been possible.

Although excessive UV radiation is damaging to living organisms, the UV rays that continue to penetrate beyond the ozone layer play a number of useful biological roles, including the promotion of the synthesis of vitamin D in human skin.

Like bacteria today, the earliest single-celled organisms did not possess nuclei. The first nucleated cells appeared about 1.5 billion years ago, and it seems that, around this time, a great evolutionary diversification began to take place among living forms, which suggests that a form of sexual reproduction was by then in existence. Previously, all reproduction had been asexual, involving the simple division of one cell into two. In sexual reproduction a new individual comes into existence through the union of two cells, the male and female *gametes*, each bringing its complement of genetic material (deoxyribonucleic acid (DNA)) from one of the parent organisms.

Around 600 to 700 million years ago, another watershed occurred in the history of life on our planet in the appearance of multicellular organisms. There is uncertainty about the timing of this evolutionary development but, by about 700 million years ago, there were flat and soft-bodied multicellular creatures in existence. They are called Ediacarans, after the Ediacara Hills in South Australia, where the first big deposits of their fossils were found.

By 500 to 600 million years ago, the Ediacarans had been replaced by very different fauna and flora, which included seaweeds, sponges, jellyfish, corals, worms, molluscs, sea urchins, starfish, lamp shells and trilobites. The various forms of life of that time, like the organisms of today, can be classified as belonging to three 'domains' — namely, the Archaea, the Bacteria and the Eukarya. The cells of Eukarya contain nuclei, and this domain includes Protista (e.g. amoebae), Fungi, Plants and Animals.

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Text 3. The evolution of life: the next 500 million years

Five hundred million years ago, there were animals swimming in the oceans that had an internal supporting structure or backbone. The earliest of these were the so-called jawless fishes, a group represented today by the lampreys. By 400 million years ago, the so-called 'true fishes' were just emerging, although the oceans were dominated by arthropods, especially trilobites.

There was much less diversity among plants. At that time all plants were thallophytes, which exhibited no real differentiation into stems, leaves and roots. This group included various kinds of multicellular algae, like stoneworts and brown seaweeds.

The main plants of the oceans have changed little since that time. In contrast, spectacular evolutionary changes took place among animals in the aquatic environment. By 200 million years ago the trilobites, which had dominated the scene for so long, had entirely disappeared and were replaced by a new group of molluscs known as ammonites. At one time there were over 20 different families of ammonites, and some of them had a diameter of at least a metre. But the ammonites were also extinct by 60 million years ago.

Meanwhile, there was remarkable diversification taking place among the bony fishes, leading eventually to the immense variety of fish species that are found in ponds, streams, rivers, lakes and oceans today.

The earliest plants to grow on land appeared on the edge of the shallow water of estuaries a little over 400 million years ago. Unlike the thallophytes in the oceans, the earliest land plants had a distinct stem that provided them with support in the new environment, and some of them had rudimentary leaves. Fossilised remains have been found of two distinct groups related to the modern psilotums and club mosses. Eventually larger plants evolved. By 350 million years ago, there were great forests of seed ferns and horsetails. Because their reproduction depended on the sperm being able to swim in a film of moisture to reach the ovum, they could exist only in moist areas. This is still the case today for the mosses, liverworts, psilotums, horsetails, ferns and club mosses. Seed ferns are now extinct.

The colonisation of drier land by plants depended on the evolution of a means of reproduction that did not require the sperm to swim through a film of water. This came about in the development of a pollen tube through which the sperm passes to reach the ovum. The first plants with a pollen tube were the gymnosperms, which appeared around 300 million years ago. There were four main kinds of gymnosperms — the cordaites, which are now extinct, and the cycads, ginkgos (maidenhair trees) and conifers.

It was also around 400 million years ago that the first animals ventured onto land. Except in the case of worms, this development involved some important structural changes that enabled them to resist drying out, to breathe atmospheric oxygen, and to move around from one place to another. The first of these requirements was met by the formation of a resistant outer skin, and the second by the development of cavities in the body into which air could pass and from which oxygen could be transported to the various tissues. Locomotion on land in the crustaceans, centipedes, spiders and, later, insects was made possible by modification of the limbs that already existed in earlier aquatic forms. The five-toed limbs of the vertebrates evolved directly from the fins of their fish ancestors.

The heyday of the amphibians was around 300 million years ago, when many diverse forms existed. By 200 million years ago, however, their numbers had declined dramatically, and their place had been taken by reptiles, including the earliest dinosaurs. Birds and mammals evolved directly from reptiles.

Reptiles, including the dinosaurs, showed extraordinary diversification, with different groups becoming adapted to many different kinds of habitat. Several aquatic groups evolved, some of which looked very much like fish, although they did not have gills and they breathed air through a respiratory tract. There were also various forms of flying reptiles, with wings spanning up to seven metres and made of leathery membranes, supported and extended by elongated fingers.

Between 60 and 70 million years ago, a great crisis occurred in reptilian history and many forms became extinct, including all the dinosaurs and flying reptiles and most of the large marine reptiles. Many other forms of life disappeared during this period of reptile extinction, including various microscopic foraminifera in the oceans and many aquatic animals, including the ammonites. Whatever the cause of this wave of extinction, placental mammals, birds, lizards, snakes, turtles, crocodiles, fishes and plants were relatively unaffected.

The earliest mammals came into existence about 200 million years ago, at about the same time that the dinosaurs were emerging as a distinct group; and there were animals very like modern echidnas wandering around 150 million years ago. But mammals remained a rather insignificant group during this period of reptile dominance.

The evolutionary transition from reptiles to mammals involved three especially important changes. First, except in the case of the egg-laying platypus and echidna, a mechanism evolved by which the embryo developed within the mother's body, attached to maternal tissue by a placenta through which oxygen, carbon dioxide, nutrients and waste products passed to and from the embryo. A somewhat similar arrangement is found in a few reptiles, such as the Australian blue-tongue skink. Second, in all mammals the newborn young are cared for by the mother and nourished by milk from her mammary glands. Third, a mechanism developed in mammals and birds that maintained a more or less constant body temperature, relatively independently of muscular activity and environment. It has been suggested that similar mechanisms may have existed in dinosaurs.

The first true flowering plants, the angiosperms, emerged about 160 million years ago and, since that time, they have undergone spectacular diversification. They are now the dominant division of plants. They are made up of two main groups — the monocotyledons and dicotyledons. The seedlings of the monocotyledons, which include grasses, lilies, irises and crocuses, have a single leaf and the stems do not thicken. The seedlings of dicotyledons have two leaves and the stems become thicker as the plant matures.

After about 60 million years ago, an amazing evolutionary diversification took place among birds and mammals. The primates, for example, which had emerged during the last part of the dinosaur era, evolved into four main groups. The most ancient group is the prosimians, which includes lemurs, aye-ayes, lorises and tarsiers. The second group, the ceboids, consists of the monkeys of South America. These animals have tails by which they can hang from branches of trees, and the group includes marmosets, howler monkeys and spider monkeys. The third group is the ceropithecoids, the monkeys of Africa and southern Asia, and it includes baboons, mandrills, langurs, and macaques. These animals also have tails, but they cannot hang by them. The fourth group, the hominoids, which includes gibbons, orangutans, chimpanzees, gorillas and humans, do not possess tails.

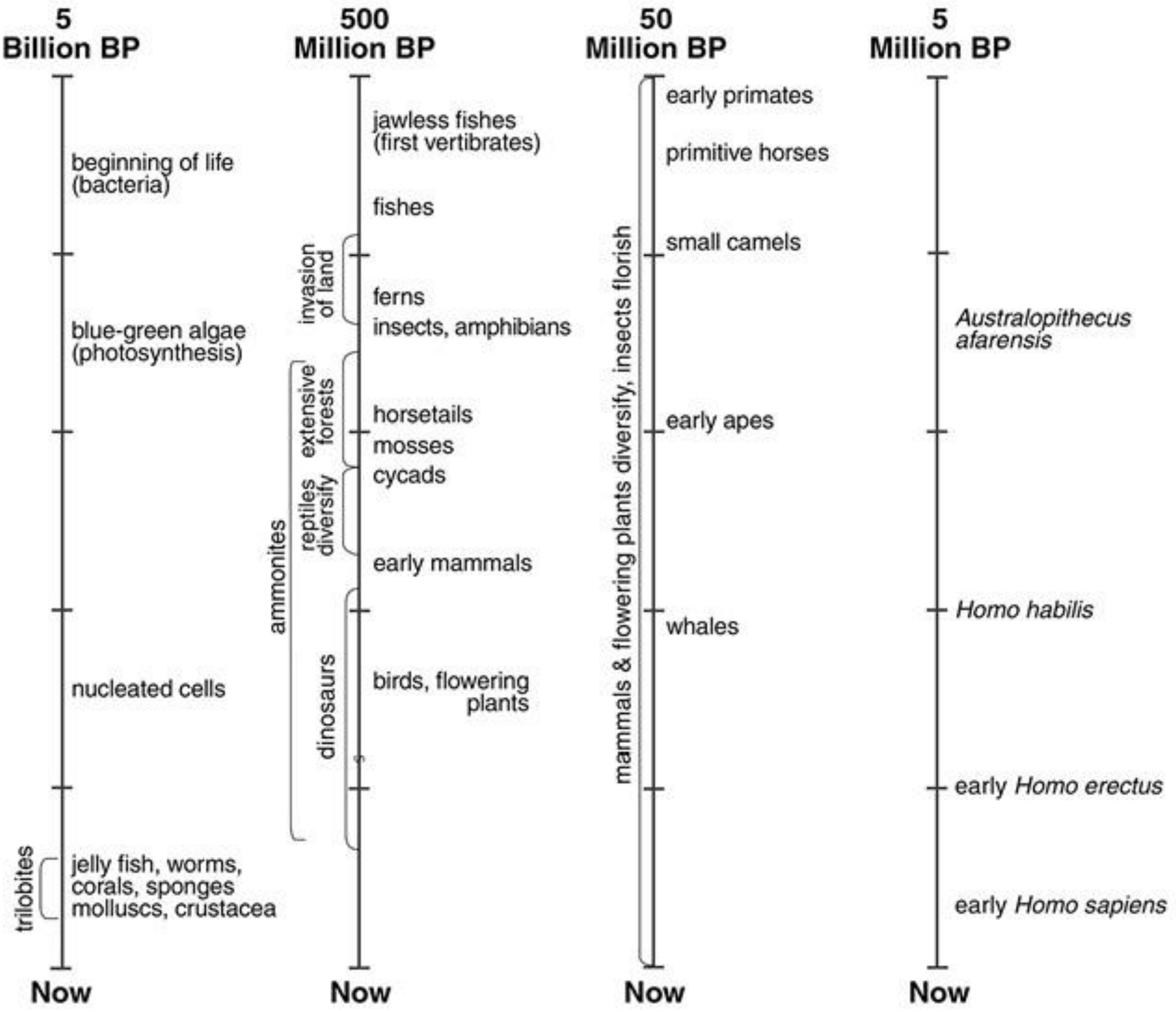

Figure 1. Some major developments in the history of life

(Source: Stephen Boyden)

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Text 4. The mechanism of evolution

According to the Darwinian explanation, evolutionary change comes about through natural selection. This process depends on the fact that, at any given time, the individuals in a population of living organisms are not genetically identical. This genetic variability is due partly to changes, or mutations, that occur spontaneously from time to time in the genetic material of the sex cells (gametes), and partly to the fact that genes occur in different combinations in different individuals.

Because the members of a population are not genetically the same, some of them are likely to be better suited than others to the prevailing conditions. These better suited individuals tend to be more successful in surviving and reproducing, and are therefore likely to contribute a greater number of individuals to the next generation. Their progeny will carry the genes that rendered their parents at a biological advantage. Consequently, generation by generation, a population can become increasingly well suited to the environment in which it lives.

Similarly, when a significant and lasting change occurs in the environment of a population, some individuals, because of the genetic variability in the population, may be better suited than others to the new conditions. These individuals are more likely to survive and successfully reproduce, passing on their genes to subsequent generations.

Not all populations adapt successfully in this way to environmental change. Indeed, the great majority of species that existed in evolutionary history eventually failed to adapt to new environmental conditions and became extinct.

The rate at which evolutionary adaptation occurs in a population following environmental change depends on a number of factors. Especially important among these is the frequency in the initial population of ‘favourable’ genes associated with resistance to the threats inherent in the new situation, and the extent to which such genes confer an advantage on the individuals that carry them (i.e. their selective advantage).

The mutation rate for individual genes is estimated to be around one mutation per 100,000 spermatozoa or ova, and most mutations are harmful rather than beneficial. The chances of a suitable or helpful mutation arising in an appropriate gene in a small population that is suddenly exposed to a new detrimental environmental condition are, therefore, negligible. In the long term, however, all major evolutionary change depends on the introduction of new genetic characteristics through random mutation.

(Retrieved from http://press-files.anu.edu.au/downloads/press/n1965/pdf/ch02.pdf})

Text 5. Ecological levels: from individuals to ecosystems

Terms individual, population, species, community and ecosystem all represent distinct ecological levels and are not synonymous, interchangeable terms.

You are an individual, your pet cat is an individual, a moose in Canada is an individual, a coconut palm tree on an island in the Indian Ocean is an individual, a gray whale cruising in the Pacific Ocean is an individual, and a tapeworm living in the gut of a cow is an individual, as is the cow itself. An individual is one organism and is also one type of organism (e.g., human, cat, moose, palm tree, gray whale, tapeworm, or cow in our example). The type of organism is referred to as the species. There are many different definitions of the word species, but for now we'll leave it simply that it is a unique type of organism.

Each species that has been studied and described by scientists has been given a two-part name, their binomial or scientific name, that uniquely identifies it (e.g., humans = Homo sapiens; domestic cats = Felis catus; moose = Alces alces; coconut palms = Cocos nucifera; gray whales = Eschrichtius robustus; cow tapeworms = Taenia saginata; and domestic cows = Bos taurus). The power or value of the scientific name is that it makes clear what type of organism you are talking about. Since only one type of organism in the entire world has that unique name, it makes for much clearer communication and understanding than using common names. If you are talking about a gopher, for example, just using its common name like this, you might be referring to a type of mammal that lives underground, a type of snake, or even a type of tortoise, depending on what part of the country you are in. If you refer to the gopher Gopherus polyphemus, you are talking only about the gopher tortoise.

So what's a population? It's a group of individuals that all belong to the same species. Populations are geographically based; they live in a particular area. But the size or scale of that area can be variable – we can talk about the human population in a city, a state, a country or a hemisphere. Or we can talk about the population of palm trees on just one island in the Indian Ocean, or on all of the islands that make up the Republic of Seychelles, or all of the islands in the Indian Ocean. The person studying or writing about the population gets to decide what scale to use, what is most appropriate for what they want to study or explain. That's one of the exciting things about science – there's a lot of freedom in defining the scope and scale of your project, but that means it is also important to explain clearly what scale you are using.

Species are made up of populations. How many populations? It all depends. It depends on how widespread the species is and how small or large the geographic area is. Some species have very limited ranges or distributions, being restricted, for example, to a single island or the top of a single mountain in the whole world. The single population on the island or mountaintop makes up the entire species. From a conservation perspective, such populations are extremely vulnerable – if anything happens to that one population, the entire species will be lost; the species will go extinct. But many species are more widespread. There are populations of moose, for example, in Yellowstone National Park, Maine, Minnesota, Alberta, Manitoba and other U.S. states and Canadian provinces. If you want to know how many moose there are on Earth, you have to know the sizes of all the different populations in all the different locations.

Communities are made up of all the populations of different species in a given area. Why the vague term "in a given area?" Because once again the scale is flexible, determined by the person studying or writing about the community. We might be talking about the community of all the organisms living in the very top or canopy of a single rainforest tree or of all the trees in the forest. What's most important about the community concept is that it involves multiple populations of all the different species in the given area and how these species interact with each other. Each of the populations is made up of individuals of a particular species, and the individuals interact with each other – with members of their own species (e.g., fighting, grooming, mating, pollinating each other) and with individuals of other species (e.g., hunting them for food, using them as a place to build a nest, growing on them). Community ecologists study the populations in a given area and their interactions. There’s another article in this tutorial about different types of ecological interactions.

That leaves us with the ecosystem level. What’s the difference between communities and ecosystems? When you’re talking about ecosystems, you’re not only looking at all the different populations and species in the given area, but you’re also looking at the physical environment, the non-living or abiotic conditions and not just what they are, but how they impact the organisms, and in some cases how the organisms impact the physical environment. For example, temperature and rainfall patterns influence where different terrestrial species of plants and animals live; some can survive dry desert conditions, others need the high rainfall found in rainforests. But the forests themselves also influence temperature and rainfall patterns. Have you ever noticed on a hot summer day how much cooler and moist it is in the shade of a forest than out in the open? And worms change the structure and composition of soil as they churn through it.

What size is an ecosystem? Guess what – it depends on how big or small the scientist or author wants to define it to be. It could be as small as your backyard, or Walden Pond, or the entire Australian outback. Different sizes or scales will be appropriate for different types of studies, reports and policies. The scientist or author just needs to explain what the size is and why it is appropriate.

(Retrieved from https://www.khanacademy.org/science/biology/ecology/intro-to-ecology/a/ecological-levels-from-individuals-to-ecosystems)

Text 6. Sustainability

Of the different forms of life that have inhabited the Earth in its three to four billion year history, 99.9% are now extinct. Against this backdrop, the human enterprise with its roughly 200,000-year history barely merits attention. As the American novelist Mark Twain once remarked, if our planet’s history were to be compared to the Eiffel Tower, human history would be a mere smear on the very tip of the tower. But while modern humans (Homo sapiens) might be insignificant in geologic time, we are by no means insignificant in terms of our recent planetary impact. A 1986 study estimated that

40% of the product of terrestrial plant photosynthesis — the basis of the food chain for most animal and bird life — was being appropriated by humans for their use. More recent studies estimate that 25% of photosynthesis on continental shelves (coastal areas) is ultimately being used to satisfy human demand. Human appropriation of such natural resources is having a profound impact upon the wide diversity of other species that also depend on them.

Evolution normally results in the generation of new lifeforms at a rate that outstrips the extinction of other species; this results in strong biological diversity. However, scientists have evidence that, for the first observable time in evolutionary history, another species — Homo sapiens — has upset this balance to the degree that the rate of species extinction is now estimated at 10,000 times the rate of species renewal. Human beings, just one species among millions, are crowding out the other species we share the planet with. Evidence of human interference with the natural world is visible in practically every ecosystem from the presence of pollutants in the stratosphere to the artificially changed courses of the majority of river systems on the planet. It is argued that ever since we abandoned nomadic, gatherer-hunter ways of life for settled societies some 12,000 years ago, humans have continually manipulated their natural world to meet their needs. While this observation is a correct one, the rate, scale, and the nature of human-induced global change — particularly in the post-industrial period — is unprecedented in the history of life on Earth.

There are three primary reasons for this. Firstly, mechanization of both industry and agriculture in the last century resulted in vastly improved labor productivity which enabled the creation of goods and services. Since then, scientific advance and technological innovation — powered by ever-increasing inputs of fossil fuels and their derivatives — have revolutionized every industry and created many new ones. The subsequent development of western consumer culture, and the satisfaction of the accompanying disposable mentality, has generated material flows of an unprecedented scale. The Wuppertal Institute estimates that humans are now responsible for moving greater amounts of matter across the planet than all natural occurrences (earthquakes, storms, etc.) put together.

Secondly, the sheer size of the human population is unprecedented. Every passing year adds another 90 million people to the planet. Even though the environmental impact varies significantly between countries (and within them), the exponential growth in human numbers, coupled with rising material expectations in a world of limited resources, has catapulted the issue of distribution to prominence. Global inequalities in resource consumption and purchasing power mark the clearest dividing line between the haves and the have-nots. It has become apparent that present patterns of production and consumption are unsustainable for a global population that is projected to reach between 12 billion by the year 2050. If ecological crises and rising social conflict are to countered, the present rates of over-consumption by a rich minority, and under-consumption by a large majority, will have to be brought into balance.

Thirdly, it is not only the rate and the scale of change but the nature of that change that is unprecedented. Human inventiveness has introduced chemicals and materials into the environment which either do not occur naturally at all, or do not occur in the ratios in which we have introduced them. These persistent chemical pollutants are believed to be causing alterations in the environment, the effects of which are only slowly manifesting themselves, and the full scale of which is beyond calculation. CFCs and PCBs are but two examples of the approximately 100,000 chemicals currently in global circulation. (Between 500 and 1,000 new chemicals are being added to this list annually.) The majority of these chemicals have not been tested for their toxicity on humans and other life forms, let alone tested for their effects in combination with other chemicals. These issues are now the subject of special UN and other intergovernmental working groups.

Our Common Future (1987), the report of the World Commission on Environment and Development, is widely credited with having popularized the concept of sustainable development. It defines sustainable development in the following ways…

…development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

… sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the orientation of the technological development, and institutional change are made consistent with future as well as present needs.

The concept of sustainability, however, can be traced back much farther to the oral histories of indigenous cultures. For example, the principle of inter-generational equity is captured in the Inuit saying, ‘we do not inherit the Earth from our parents, we borrow it from our children’. The Native American ‘Law of the Seventh Generation’ is another illustration. According to this, before any major action was to be undertaken its potential consequences on the seventh generation had to be considered. For a species that at present is only 6,000 generations old and whose current political decision-makers operate on time scales of months or few years at most, the thought that other human cultures have based their decision-making systems on time scales of many decades seems wise but unfortunately inconceivable in the current political climate.

A sustainable ethic is an environmental ethic by which people treat the earth as if its resources are limited. This ethic assumes that the earth’s resources are not unlimited and that humans must use and conserve resources in a manner that allows their continued use in the future. A sustainable ethic also assumes that humans are a part of the natural environment and that we suffer when the health of a natural ecosystem is impaired. A sustainable ethic includes the following tenets:

The earth has a limited supply of resources.

Humans must conserve resources.

Humans share the earth’s resources with other living things.

Growth is not sustainable.

Humans are a part of nature.

Humans are affected by natural laws.

Humans succeed best when they maintain the integrity of natural processes sand cooperate with nature.

For example, if a fuel shortage occurs, how can the problem be solved in a way that is consistent with a sustainable ethic? The solutions might include finding new ways to conserve oil or developing renewable energy alternatives. A sustainable ethic attitude in the face of such a problem would be that if drilling for oil damages the ecosystem, then that damage will affect the human population as well. A sustainable ethic can be either anthropocentric or biocentric (life-centered). An advocate for conserving oil resources may consider all oil resources as the property of humans. Using oil resources wisely so that future generations have access to them is an attitude consistent with an anthropocentric ethic. Using resources wisely to prevent ecological damage is in accord with a biocentric ethic.

(Retrieved from https://openoregon.pressbooks.pub/envirobiology/chapter/1-3-environment-sustainability/)

Text 7. Biodiversity

Biologists estimate that species extinctions are currently 500–1000 times the normal, or background, rate seen previously in Earth's history. The current high rates will cause a precipitous decline in the biodiversity of the planet in the next century or two. The loss of biodiversity will include many species we know today. Although it is sometimes difficult to predict which species will become extinct, many are listed as endangered (at great risk of extinction). However, many extinctions will affect species that biologist have not yet discovered. Most of these "invisible" species that will become extinct currently live in tropical rainforests like those of the Amazon basin. These rainforests are the most diverse ecosystems on the planet and are being destroyed rapidly by deforestation. Between 1970 and 2011, almost 20 percent of the Amazon rainforest was lost.

Biodiversity is a broad term for biological variety, and it can be measured at a number of organizational levels. Traditionally, ecologists have measured biodiversity by taking into account both the number of species and the number of individuals of each species (known as relative abundance). However, biologists are using different measures of biodiversity, including genetic diversity, to help focus efforts to preserve the biologically and technologically important elements of biodiversity.

Biodiversity loss refers to the reduction of biodiversity due to displacement or extinction of species. The loss of a particular individual species may seem unimportant to some, especially if it is not a charismatic species like the Bengal tiger or the bottlenose dolphin. However, the current accelerated extinction rate means the loss of tens of thousands of species within our lifetimes. Much of this loss is occurring in tropical rainforests, which are very high in biodiversity but are being cleared for timber and agriculture. This is likely to have dramatic effects on human welfare through the collapse of ecosystems.

Biologists recognize that human populations are embedded in ecosystems and are dependent on them, just as is every other species on the planet. Agriculture began after early hunter-gatherer societies first settled in one place and heavily modified their immediate environment. This cultural transition has made it difficult for humans to recognize their dependence on living things other than crops and domesticated animals on the planet. Today our technology smooths out the harshness of existence and allows many of us to live longer, more comfortable lives, but ultimately the human species cannot exist without its surrounding ecosystems. Our ecosystems provide us with food, medicine, clean air and water, recreation, and spiritual and aesthetical inspiration.

A common meaning of biodiversity is simply the number of species in a location or on Earth; for example, the American Ornithologists' Union lists 2078 species of birds in North and Central America. This is one measure of the bird biodiversity on the continent. More sophisticated measures of diversity take into account the relative abundances of species. For example, a forest with 10 equally common species of trees is more diverse than a forest that has 10 species of trees wherein just one of those species makes up 95 percent of the trees. Biologists have also identified alternate measures of biodiversity, some of which are important in planning how to preserve biodiversity.

Genetic diversity is one alternate concept of biodiversity. Genetic diversity is the raw material for evolutionary adaptation in a species and is represented by the variety of genes present within a population. A species' potential to adapt to changing environments or new diseases depends on this genetic diversity.

It is also useful to define ecosystem diversity: the number of different ecosystems on Earth or in a geographical area. The loss of an ecosystem means the loss of the interactions between species and the loss of biological productivity that an ecosystem is able to create. An example of a largely extinct ecosystem in North America is the prairie ecosystem. Prairies once spanned central North America from the boreal forest in northern Canada down into Mexico. They are now all but gone, replaced by crop fields, pasture lands, and suburban sprawl. Many of the species survive, but the hugely productive ecosystem that was responsible for creating our most productive agricultural soils is now gone. As a consequence, their soils are now being depleted unless they are maintained artificially at great expense. The decline in soil productivity occurs because the interactions in the original ecosystem have been lost.

Despite considerable effort, knowledge of the species that inhabit the planet is limited. A recent estimate suggests that only 13% of eukaryotic species have been named. Estimates of numbers of prokaryotic species are largely guesses, but biologists agree that science has only just begun to catalog their diversity. . Given that Earth is losing species at an accelerating pace, science knows little about what is being lost.

There are various initiatives to catalog described species in accessible and more organized ways, and the internet is facilitating that effort. Nevertheless, at the current rate of species description, which according to the State of Observed Species1 reports is 17,000–20,000 new species a year, it would take close to 500 years to describe all of the species currently in existence. The task, however, is becoming increasingly impossible over time as extinction removes species from Earth faster than they can be described.

Naming and counting species may seem an unimportant pursuit given the other needs of humanity, but it is not simply an accounting. Describing species is a complex process by which biologists determine an organism's unique characteristics and whether or not that organism belongs to any other described species. It allows biologists to find and recognize the species after the initial discovery to follow up on questions about its biology. That subsequent research will produce the discoveries that make the species valuable to humans and to our ecosystems. Without a name and description, a species cannot be studied in depth and in a coordinated way by multiple scientists.

(Retrieved from https://courses.lumenlearning.com/suny-monroe-environmentalbiology/chapter/5-3-importance-of-biodiversity/)

Text 8. Patterns of biodiversity

Biodiversity is not evenly distributed on the planet. Lake Victoria contained almost 500 species of cichlids (just one family of fishes that are present in the lake) before the introduction of an exotic species in the 1980s and 1990s caused a mass extinction. All of these species were found only in Lake Victoria, which is to say they were endemic. Endemic species are found in only one location. For example, the blue jay is endemic to North America, while the Barton Springs salamander is endemic to the mouth of one spring in Austin, Texas. Endemic species with highly restricted distributions, like the Barton Springs salamander, are particularly vulnerable to extinction.

Lake Huron contains about 79 species of fish, all of which are found in many other lakes in North America. What accounts for the difference in diversity between Lake Victoria and Lake Huron? Lake Victoria is a tropical lake, while Lake Huron is a temperate lake. Lake Huron in its present form is only about 7,000 years old, while Lake Victoria in its present form is about 15,000 years old. These two factors, latitude and age, are two of several hypotheses biogeographers have suggested to explain biodiversity patterns on Earth.

Biogeography is the study of the distribution of the world's species both in the past and in the present. The work of biogeographers is critical to understanding our physical environment, how the environment affects species, and how changes in environment impact the distribution of a species.

There are three main fields of study under the heading of biogeography: ecological biogeography, historical biogeography (called paleobiogeography), and conservation biogeography. Ecological biogeography studies the current factors affecting the distribution of plants and animals. Historical biogeography, as the name implies, studies the past distribution of species. Conservation biogeography, on the other hand, is focused on the protection and restoration of species based upon the known historical and current ecological information.

One of the oldest observed patterns in ecology is that biodiversity typically increases as latitude declines. In other words, biodiversity increases closer to the equator. It is not yet clear why biodiversity increases closer to the equator, but hypotheses include the greater age of the ecosystems in the tropics versus temperate regions, which were largely devoid of life or drastically impoverished during the last ice age. The greater age provides more time for speciation, the evolutionary process of creating new species. Another possible explanation is the greater energy the tropics receive from the sun. But scientists have not been able to explain how greater energy input could translate into more species. The complexity of tropical ecosystems may promote speciation by increasing the habitat complexity, thus providing more ecological niches. Lastly, the tropics have been perceived as being more stable than temperate regions, which have a pronounced climate and day-length seasonality. The stability of tropical ecosystems might promote speciation. Regardless of the mechanisms, it is certainly true that biodiversity is greatest in the tropics. There are also high numbers of endemic species.

(Retrieved from https://courses.lumenlearning.com/suny-monroe-environmentalbiology/chapter/5-3-importance-of-biodiversity/)

Text 9. Energy and ecology

The rich diversity of plants and animals that exist in the modern world, including humans and their civilisation, could not exist without photosynthesis.

Plants use about half the energy they capture from sunlight in their own vital processes, eventually releasing it into the environment in the form of heat. The remaining energy takes one of several pathways. Dead plant tissue containing stored energy is broken down by bacteria or fungi, which make use of the energy in their own vital processes and eventually release it into the environment as heat. Some plant tissue is consumed by plant-eating animals, providing them with the energy they need for their life processes. Some of this energy is given off in the form of heat, while some of it is retained in the animals' own tissues, eventually to be consumed either by carnivores or by microorganisms, and ultimately returned to the environment in the form of heat. This sequence of events is referred to as a food chain, with plants playing the role of producers, animals the role of consumers, and microorganisms and fungi the role of decomposers (Figure 2). Sometimes the chemical energy stored in plants is converted directly to heat through the action of fire.

A very small fraction of dead plant tissue avoids these various fates and only partially decomposes. Under certain conditions, like those that are likely to exist in swamps or bogs, decomposition of dead plant material may be incomplete due to lack of oxygen in the stagnant water and acidity resulting from the decay process. The soft, fibrous energy-containing material formed in this way is called peat. Downward pressure resulting from the accumulation of sediments above may eventually transform peat into coal.

Petroleum and fossil gas, which are also of organic origin, are produced by the breakdown of vast quantities of microscopic plants and animals in the oceans. Unlike coal, the liquid and gaseous hydrocarbons often migrate from their place of origin to become concentrated in distant reservoirs. The formation of the deposits of these fossil hydrocarbons spanned several hundred million years. They are now being used by humans as sources of energy at a rate that is several million times faster than the rate at which they were formed.

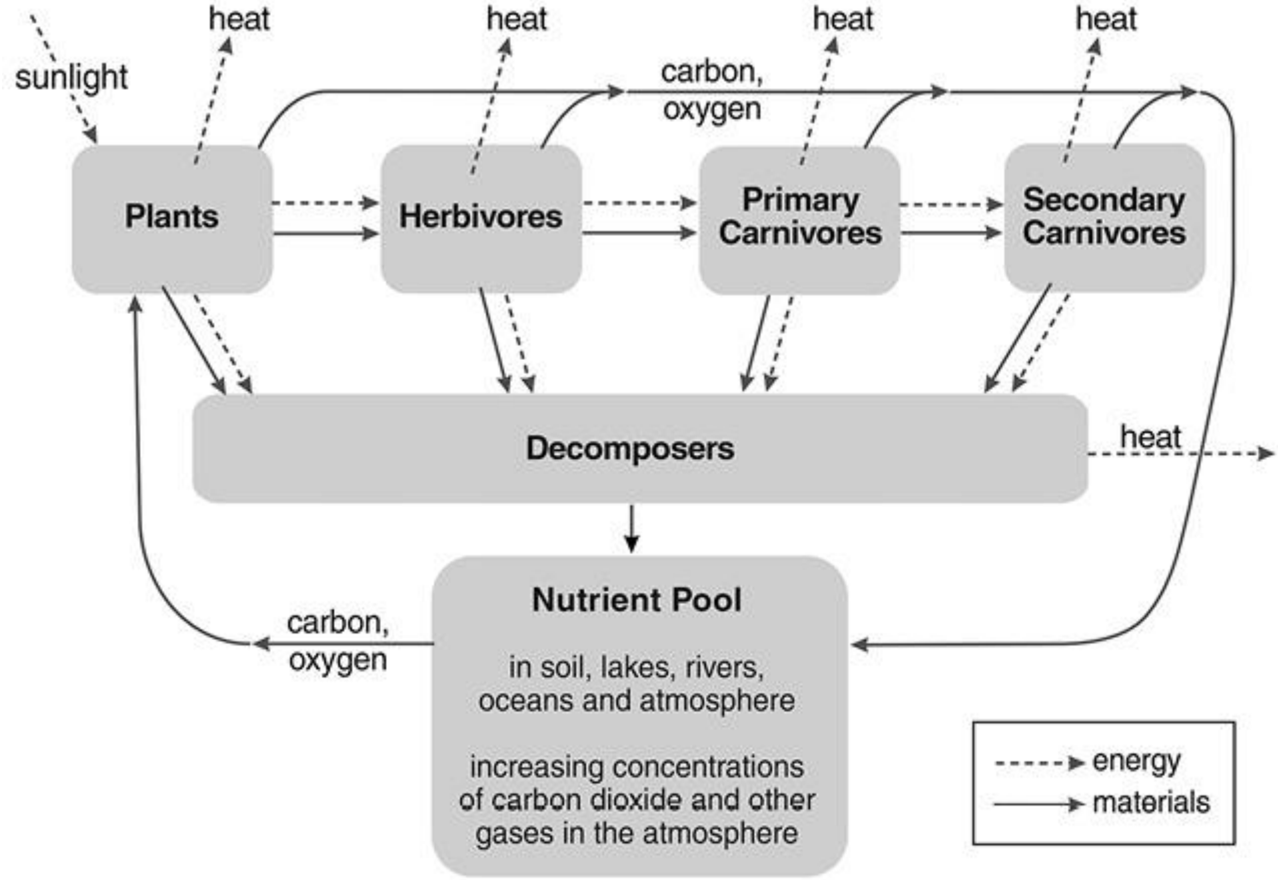

Figure 2. The nature of food chains

(Source: Stephen Boyden)

Nutrient cycles. While the energy on which life processes depend comes from outside the biosphere in the form of light and is eventually returned to outer space as heat, the material components of living organisms come from the planet itself.

An essential characteristic of life on Earth is the cycling within the system of chemical elements that are taken up from the environment, built into the tissues of living organisms, and then eventually released again into the environment — to become available for incorporation into new life.

Plants take up the various nutrients that they need for their growth from their immediate environment. Carbon is taken from the atmosphere and oxygen from the atmosphere, soil and water. All other essential nutrients are taken from the soil and water.

These nutrient cycles are essential for the sustainability of life in all natural terrestrial ecosystems.

The different nutrient cycles vary in complexity. The carbon and oxygen cycles are intimately connected and are relatively simple (Figure 3). The nitrogen cycle is more complicated. Plants take up the nitrogen that they need for growth from the soil and water in the form of sodium nitrate. This is made available largely through the activities of certain bacteria in the soil, some of which manufacture it from breakdown products of decomposers, and some by fixing free nitrogen from the atmosphere so that it becomes assimilated into organic compounds.

Indeed, the whole of multicellular life on Earth is ultimately dependent on the activities of microbes because of the essential roles that they play in the breakdown of the tissue of dead plants and animals and in the cycling of nutrients.

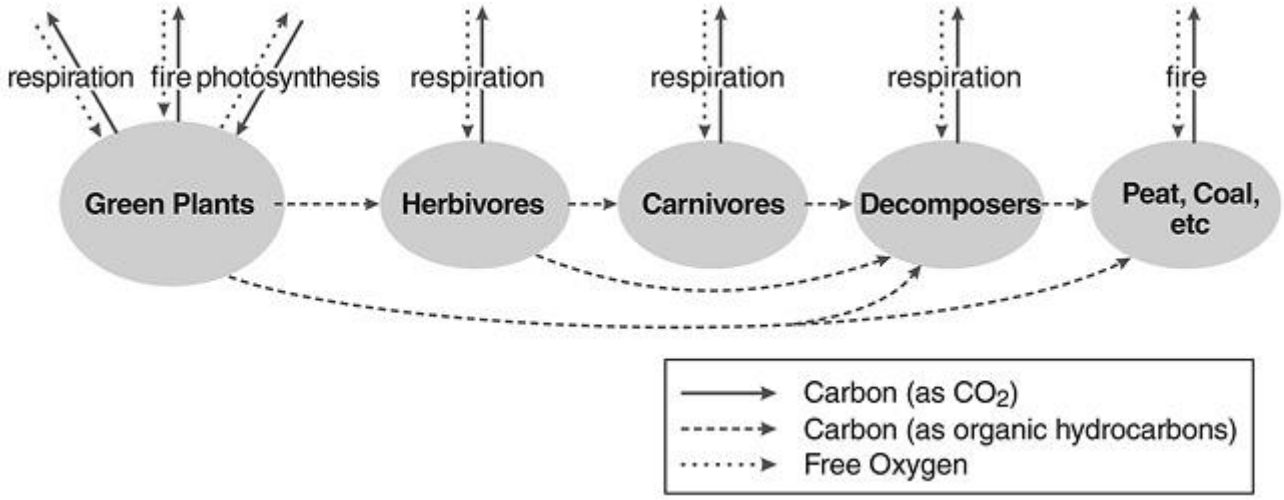

Figure 3. Carbon and oxygen cycles

(Source: Stephen Boyden)

(Retrieved from https://press-files.anu.edu.au/downloads/press/n1965/html/ch02.xhtml?referer=&page=6#)

Text 10. The Gulf of Mexico dead zone

The Gulf of Mexico dead zone is an area of hypoxic (less than 2 ppm dissolved oxygen) waters at the mouth of the Mississippi River. Its area varies in size, but can cover up to 6,000-7,000 square miles. The zone occurs between the inner and mid-continental shelf in the northern Gulf of Mexico, beginning at the Mississippi River delta and extending westward to the upper Texas coast.

Dead zones can be found worldwide. The Gulf of Mexico dead zone is one of the largest in the world. Marine dead zones can be found in the Baltic Sea, Black Sea, off the coast of Oregon, and in the Chesapeake Bay. Dead zones may also be found in lakes, such as Lake Erie.

The dead zone is caused by nutrient enrichment from the Mississippi River, particularly nitrogen and phosphorous. Watersheds within the Mississippi River Basin drain much of the United States, from Montana to Pennsylvania and extending southward along the Mississippi River. Most of the nitrogen input comes from major farming states in the Mississippi River Valley, including Minnesota, Iowa, Illinois, Wisconsin, Missouri, Tennessee, Arkansas, Mississippi, and Louisiana. Nitrogen and phosphorous enter the river through upstream runoff of fertilizers, soil erosion, animal wastes, and sewage. In a natural system, these nutrients aren't significant factors in algae growth because they are depleted in the soil by plants. However, with anthropogenically increased nitrogen and phosphorus input, algae growth is no longer limited. Consequently, algal blooms develop, the food chain is altered, and dissolved oxygen in the area is depleted. The size of the dead zone fluctuates seasonally, as it is exacerbated by farming practices. It is also affected by weather events such as flooding and hurricanes.

Nutrient overloading and algal blooms lead to, which has been shown to reduce benthic biomass and biodiversity. Hypoxic water supports fewer organisms and has been linked to massive fish kills in the Black Sea and Gulf of Mexico.

The Gulf of Mexico is a major source area for the seafood industry. The Gulf supplies 72% of U.S. harvested shrimp, 66% of harvested oysters, and 16% of commercial fish (Potash and Phosphate Institutes of the U.S. and Canada, 1999). Consequently, if the hypoxic zone continues or worsens, fishermen and coastal state economies will be greatly impacted.

What can be done to remediate the poblem? The key to minimizing the Gulf dead zone is to address it at the source. Solutions include:

Using fewer fertilizers and adjusting the timing of fertilizer applications to limit runoff of excess nutrients from farmland;

Control of animal wastes so that they are not allowed to enter into waterways;

Monitoring of septic systems and sewage treatment facilities to reduce discharge of nutrients to surface water and groundwater;

Careful industrial practices such as limiting the discharge of nutrients, organic matter, and chemicals from manufacturing facilities.

These solutions are relatively simple to implement and would significantly reduce the input of nitrogen and phosphorus to the Gulf of Mexico. A similar approach has been used successfully in the Great Lakes' recovery from eutrophication.

The government is also funding efforts to restore wetlands along the Gulf coast to naturally filter the water before it enters the Gulf.

(Retrieved from https://serc.carleton.edu/microbelife/topics/deadzone/index.html)

Text 11. Water cycle and fresh water supply

Water, air, and food are the most important natural resources to people. Humans can live only a few minutes without oxygen, less than a week without water, and about a month without food. Water also is essential for our oxygen and food supply. Plants breakdown water and use it to create oxygen during the process of photosynthesis.

Water is the most essential compound for all living things. Human babies are approximately 75% water and adults are 60% water. Our brain is about 85% water, blood and kidneys are 83% water, muscles are 76% water, and even bones are 22% water. We constantly lose water by perspiration; in temperate climates we should drink about 2 quarts of water per day and people in hot desert climates should drink up to 10 quarts of water per day. Loss of 15% of body-water usually causes death.

Earth is truly the Water Planet. The abundance of liquid water on Earth’s surface distinguishes us from other bodies in the solar system. About 70% of Earth’s surface is covered by oceans and approximately half of Earth's surface is obscured by clouds (also made of water) at any time. There is a very large volume of water on our planet, about 1.4 billion cubic kilometers (km3) (330 million cubic miles) or about 53 billion gallons per person on Earth. All of Earth's water could cover the United States to a depth of 145 km (90 mi). From a human perspective, the problem is that over 97% of it is seawater, which is too salty to drink or use for irrigation. The most commonly used water sources are rivers and lakes, which contain less than 0.01% of the world's water!

One of the most important environmental goals is to provide clean water to all people. Fortunately, water is a renewable resource and is difficult to destroy. Evaporation and precipitation combine to replenish our fresh water supply constantly; however, water availability is complicated by its uneven distribution over the Earth. Arid climate and densely populated areas have combined in many parts of the world to create water shortages, which are projected to worsen in the coming years due to population growth and climate change. Human activities such as water overuse and water pollution have compounded significantly the water crisis that exists today. Hundreds of millions of people lack access to safe drinking water, and billions of people lack access to improved sanitation as simple as a pit latrine. As a result, nearly two million people die every year from diarrheal diseases and 90% of those deaths occur among children under the age of 5. Most of these are easily prevented deaths.

Water reservoirs and water cycle. Water is the only common substance that occurs naturally on earth in three forms: solid, liquid and gas. It is distributed in various locations, called water reservoirs. The oceans are by far the largest of the reservoirs with about 97% of all water but that water is too saline for most human uses (Figure 4). Ice caps and glaciers are the largest reservoirs of fresh water but this water is inconveniently located, mostly in Antarctica and Greenland. Shallow groundwater is the largest reservoir of usable fresh water. Although rivers and lakes are the most heavily used water resources, they represent only a tiny amount of the world's water. If all of world's water was shrunk to the size of 1 gallon, then the total amount of fresh water would be about 1/3 cup, and the amount of readily usable fresh water would be 2 tablespoons.

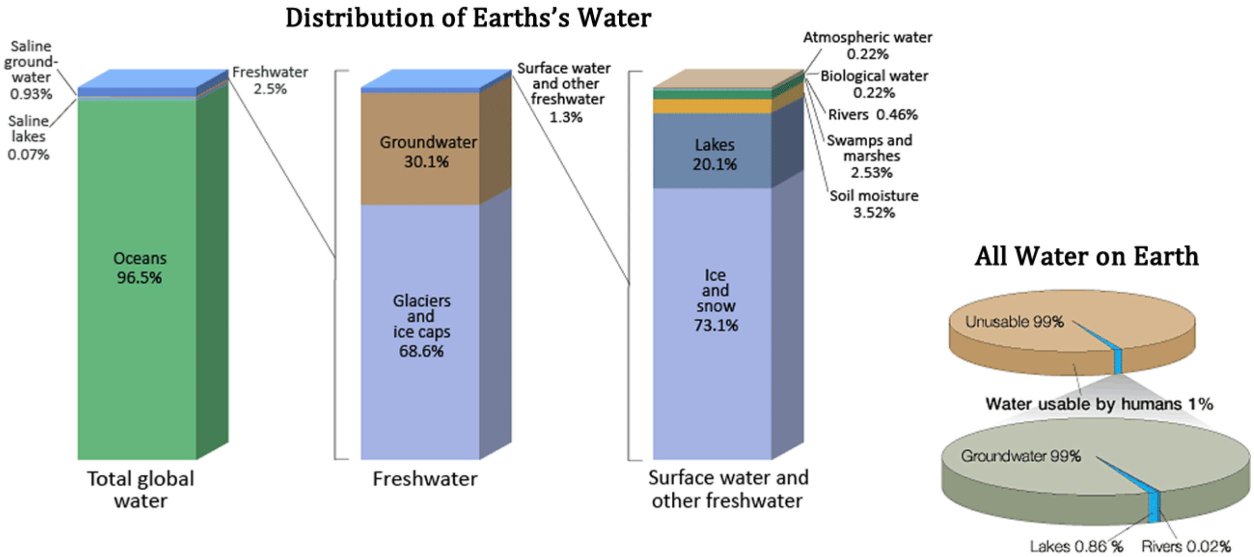

Figure 4. Earth's Water Reservoirs. Bar chart Distribution of Earth's water including total global water, fresh water, and surface water and other fresh water and Pie chart Water usable by humans and sources of usable water.

(Source: United States Geographical Survey Igor Skiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources)

The water (or hydrologic) cycle shows the movement of water through different reservoirs, which include oceans, atmosphere, glaciers, groundwater, lakes, rivers, and biosphere. Solar energy and gravity drive the motion of water in the water cycle. Simply put, the water cycle involves water moving from oceans, rivers, and lakes to the atmosphere by evaporation, forming clouds. From clouds, it falls as precipitation (rain and snow) on both water and land. The water on land can either return to the ocean by surface runoff, rivers, glaciers, and subsurface groundwater flow, or return to the atmosphere by evaporation or transpiration (loss of water by plants to the atmosphere).

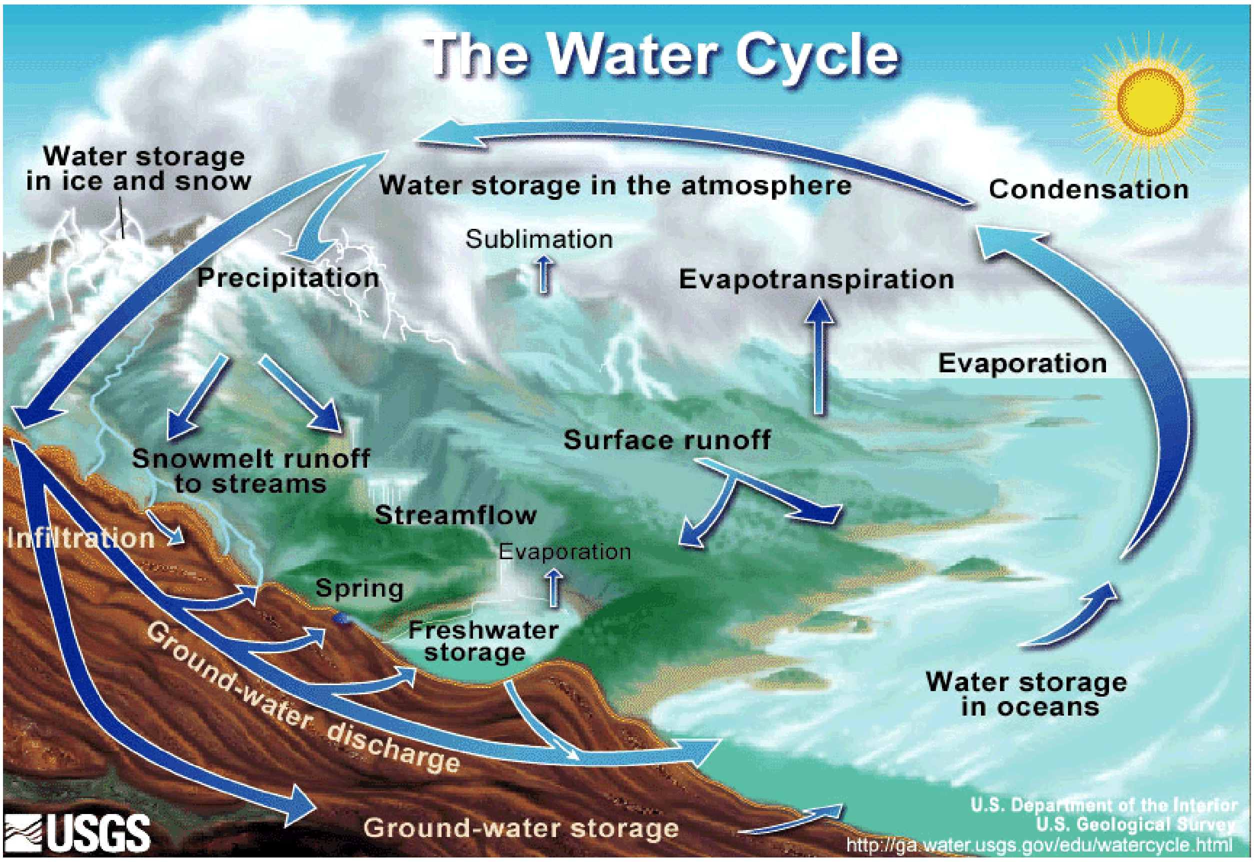

Figure 5. The Water Cycle. Arrows depict movement of water to different reservoirs located above, at, and below Earth's surface.

(Source: United States Geological Survey)

An important part of the water cycle is how water varies in salinity, which is the abundance of dissolved ions in water. The saltwater in the oceans is highly saline, with about 35,000 mg of dissolved ions per liter of seawater. Evaporation (where water changes from liquid to gas at ambient temperatures) is a distillation process that produces nearly pure water with almost no dissolved ions. As water vaporizes, it leaves the dissolved ions in the original liquid phase. Eventually, condensation (where water changes from gas to liquid) forms clouds and sometimes precipitation (rain and snow). After rainwater falls onto land, it dissolves minerals in rock and soil, which increases its salinity. Most lakes, rivers, and near-surface groundwater have a relatively low salinity and are called freshwater.

(Retrieved from https://openoregon.pressbooks.pub/envirobiology/chapter/7-1-water-cycle-and-fresh-water-supply/)

Text 12. Surface and ground water resources

Flowing water from rain and melted snow on land enters river channels by surface runoff and groundwater seepage. River discharge describes the volume of water moving through a river channel over time. The relative contributions of surface runoff vs. groundwater seepage to river discharge depend on precipitation patterns, vegetation, topography, land use, and soil characteristics. Soon after a heavy rainstorm, river discharge increases due to surface runoff. The steady normal flow of river water is mainly from groundwater that discharges into the river. Gravity pulls river water downhill toward the ocean. Along the way the moving water of a river can erode soil particles and dissolve minerals. Groundwater also contributes a large amount of the dissolved minerals in river water. The geographic area drained by a river and its tributaries is called a drainage basin or watershed. The Mississippi River drainage basin includes approximately 40% of the U.S., a measure that includes the smaller drainage basins, such as the Ohio River and Missouri River that help to comprise it. Rivers are an important water resource for irrigation of cropland and drinking water for many cities around the world. Rivers that have had international disputes over water supply include the Colorado (Mexico, southwest U.S.), Nile (Egypt, Ethiopia, Sudan), Euphrates (Iraq, Syria, Turkey), Ganges (Bangladesh, India), and Jordan (Israel, Jordan, Syria).

In addition to rivers, lakes can also be an excellent source of freshwater for human use. They usually receive water from surface runoff and groundwater discharge. They tend to be short-lived on a geological time-scale because they are constantly filling in with sediment supplied by rivers. Lakes form in a variety of ways including glaciation, recent tectonic uplift (e.g., Lake Tanganyika, Africa), and volcanic eruptions (e.g., Crater Lake, Oregon). People also create artificial lakes (reservoirs) by damming rivers. Large changes in climate can result in major changes in a lake’s size. As Earth was coming out of the last Ice Age about 15,000 years ago, the climate in the western U.S. changed from cool and moist to warm and arid, which caused more than 100 large lakes to disappear. The Great Salt Lake in Utah is a remnant of a much larger lake called Lake Bonneville.

Although glaciers represent the largest reservoir of fresh water, they generally are not used as a water source because they are located too far from most people. Melting glaciers do provide a natural source of river water and groundwater. During the last Ice Age there was as much as 50% more water in glaciers than there is today, which caused sea level to be about 100 m lower. Over the past century, sea level has been rising in part due to melting glaciers. If Earth's climate continues to warm, the melting glaciers will cause an additional rise in sea level.

Although most people in the world use surface water, groundwater is a much larger reservoir of usable fresh water, containing more than 30 times more water than rivers and lakes combined. Groundwater is a particularly important resource in arid climates, where surface water may be scarce. In addition, groundwater is the primary water source for rural homeowners, providing 98% of that water demand in the U.S.. Groundwater is water located in small spaces, called pore space, between mineral grains and fractures in subsurface earth materials (rock or sediment). Most groundwater originates from rain or snowmelt, which infiltrates the ground and moves downward until it reaches the saturated zone (where groundwater completely fills pore spaces in earth materials).

Other sources of groundwater include seepage from surface water (lakes, rivers, reservoirs, and swamps), surface water deliberately pumped into the ground, irrigation, and underground wastewater treatment systems (septic tanks). Recharge areas are locations where surface water infiltrates the ground rather than running into rivers or evaporating. Wetlands, for example, are excellent recharge areas. A large area of sub-surface, porous rock that holds water is an aquifer. Aquifers are commonly drilled, and wells installed, to provide water for agriculture and personal use.

(Retrieved from https://openoregon.pressbooks.pub/envirobiology/chapter/7-1-water-cycle-and-fresh-water-supply/)

Text 13. Water pollution

The global water crisis also involves water pollution. For water to be useful for drinking and irrigation, it must not be polluted beyond certain thresholds. According to the World Health Organization, in 2008 approximately 880 million people in the world (or 13% of world population) did not have access to safe drinking water. At the same time, about 2.6 billion people (or 40% of world population) lived without improved sanitation, which is defined as having access to a public sewage system, septic tank, or even a simple pit latrine. Each year approximately 1.7 million people die from diarrheal diseases associated with unsafe drinking water, inadequate sanitation, and poor hygiene. Almost all of these deaths are in developing countries, and around 90% of them occur among children under the age of 5. Compounding the water crisis is the issue of social justice; poor people more commonly lack clean water and sanitation than wealthy people in similar areas. Globally, improving water safety, sanitation, and hygiene could prevent up to 9% of all disease and 6% of all deaths.

In addition to the global waterborne disease crisis, chemical pollution from agriculture, industry, cities, and mining threatens global water quality. Some chemical pollutants have serious and well-known health effects, whereas many others have poorly known long-term health effects. In the U.S. currently more than 40,000 water bodies fit the definition of "impaired" set by EPA, which means they could neither support a healthy ecosystem nor meet water quality standards. In Gallup public polls conducted over the past decade Americans consistently put water pollution and water supply as the top environmental concerns over issues such as air pollution, deforestation, species extinction, and global warming.

Any natural water contains dissolved chemicals, some of which are important human nutrients while others can be harmful to human health. The concentration of a water pollutant is commonly given in very small units such as parts per million (ppm) or even parts per billion (ppb). An arsenic concentration of 1 ppm means 1 part of arsenic per million parts of water. This is equivalent to one drop of arsenic in 50 liters of water. To give you a different perspective on appreciating small concentration units, converting

1 ppm to length units is 1 cm (0.4 in) in 10 km (6 miles) and converting 1 ppm to time units is 30 seconds in a year. Total dissolved solids (TDS) represent the total amount of dissolved material in water. Average TDS values for rainwater, river water, and seawater are about 4 ppm, 120 ppm, and 35,000 ppm, respectively.

Water pollution is the contamination of water by an excess amount of a substance that can cause harm to human beings and/or the ecosystem. The level of water pollution depends on the abundance of the pollutant, the ecological impact of the pollutant, and the use of the water. Pollutants are derived from biological, chemical, or physical processes. Although natural processes such as volcanic eruptions or evaporation sometimes can cause water pollution, most pollution is derived from human, land-based activities. Water pollutants can move through different water reservoirs, as the water carrying them progresses through stages of the water cycle (Figure 6). Water residence time (the average time that a water molecule spends in a water reservoir) is very important to pollution problems because it affects pollution potential. Water in rivers has a relatively short residence time, so pollution usually is there only briefly. Of course, pollution in rivers may simply move to another reservoir, such as the ocean, where it can cause further problems. Groundwater is typically characterized by slow flow and longer residence time, which can make groundwater pollution particularly problematic. Finally, pollution residence time can be much greater than the water residence time because a pollutant may be taken up for a long time within the ecosystem or absorbed onto sediment.

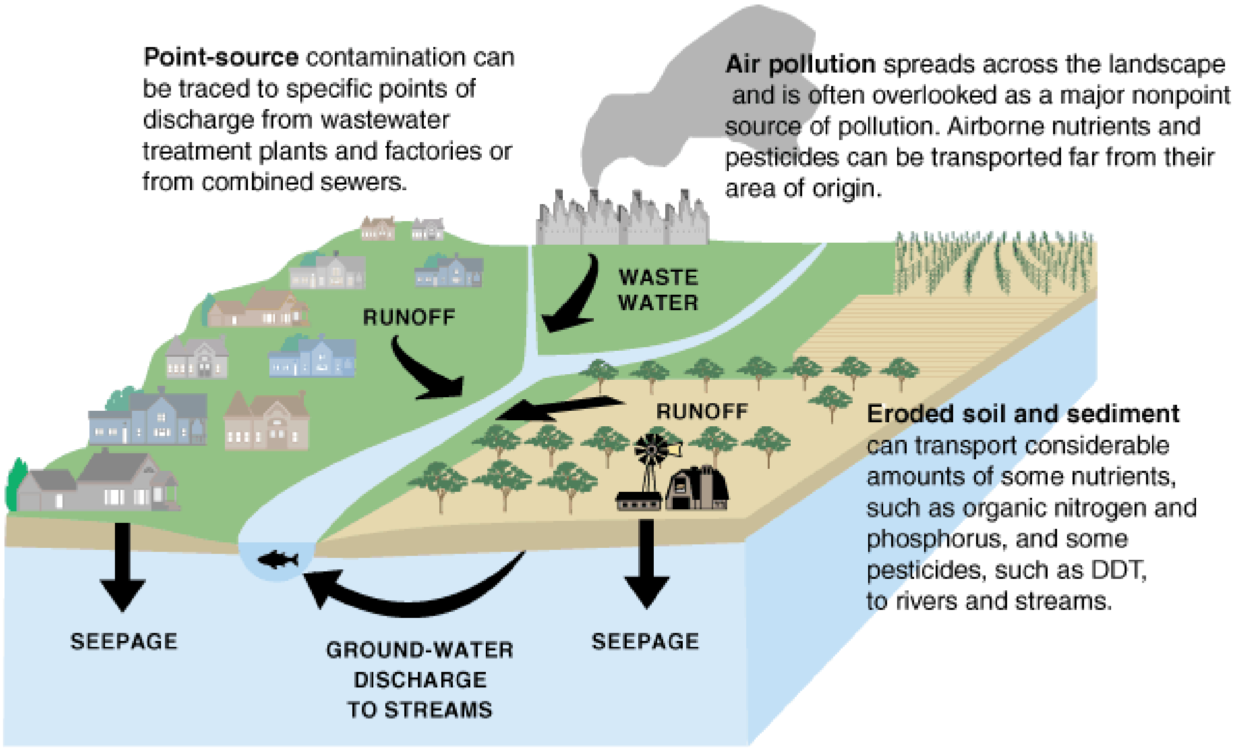

Figure 6. Sources of Water Contamination. Sources of some water pollutants and movement of pollutants into different water reservoirs of the water cycle.

(Source: U.S. Geological Survey)

Pollutants enter water supplies from point sources, which are readily identifiable and relatively small locations, or nonpoint sources, which are large and more diffuse areas. Point sources of pollution include animal factory farms that raise a large number and high density of livestock such as cows, pigs, and chickens. Also, pipes included are pipes from a factories or sewage treatment plants. Combined sewer systems that have a single set of underground pipes to collect both sewage and storm water runoff from streets for wastewater treatment can be major point sources of pollutants. During heavy rain, storm water runoff may exceed sewer capacity, causing it to back up and spilling untreated sewage directly into surface waters.

Nonpoint sources of pollution include agricultural fields, cities, and abandoned mines. Rainfall runs over the land and through the ground, picking up pollutants such as herbicides, pesticides, and fertilizer from agricultural fields and lawns; oil, antifreeze, animal waste, and road salt from urban areas; and acid and toxic elements from abandoned mines. Then, this pollution is carried into surface water bodies and groundwater. Nonpoint source pollution, which is the leading cause of water pollution in the U.S., is usually much more difficult and expensive to control than point source pollution because of its low concentration, multiple sources, and much greater volume of water.

(Retrieved from https://openoregon.pressbooks.pub/envirobiology/chapter/7-3-water-pollution/)

Text 14. Types of water pollutants

Oxygen-demanding waste is an extremely important pollutant to ecosystems. Most surface water in contact with the atmosphere has a small amount of dissolved oxygen, which is needed by aquatic organisms for cellular respiration. Bacteria decompose dead organic matter and remove dissolved oxygen (O2) according to the following reaction:

$$organic\ matter + O2 \rightarrow CO2 + H2O$$

Too much decaying organic matter in water is a pollutant because it removes oxygen from water, which can kill fish, shellfish, and aquatic insects. The amount of oxygen used by aerobic (in the presence of oxygen) bacterial decomposition of organic matter is called biochemical oxygen demand (BOD). The major source of dead organic matter in many natural waters is sewage; grass and leaves are smaller sources. An unpolluted water body with respect to BOD is a turbulent river that flows through a natural forest. Turbulence continually brings water in contact with the atmosphere where the O2 content is restored. The dissolved oxygen content in such a river ranges from 10 to 14 ppm O2, BOD is low, and clean-water fish such as trout. A polluted water body with respect to oxygen is a stagnant deep lake in an urban setting with a combined sewer system. This system favors a high input of dead organic carbon from sewage overflows and limited chance for water circulation and contact with the atmosphere. In such a lake, the dissolved O2 content is ≤5 ppm O2, BOD is high, and low O2-tolerant fish, such as carp and catfish dominate.

Excessive plant nutrients, particularly nitrogen (N) and phosphorous (P), are pollutants closely related to oxygen-demanding waste. Aquatic plants require about 15 nutrients for growth, most of which are plentiful in water. N and P are called limiting nutrients, however, because they usually are present in water at low concentrations and therefore restrict the total amount of plant growth. This explains why N and P are major ingredients in most fertilizer. High concentrations of N and P from human sources (mostly agricultural and urban runoff including fertilizer, sewage, and phosphorus-based detergent) can cause cultural eutrophication, which leads to the rapid growth of aquatic producers, particularly algae. Thick mats of floating algae or rooted plants lead to a form of water pollution that damages the ecosystem by clogging fish gills and blocking sunlight. A small percentage of algal species produce toxins that can kill animals, including humans. Exponential growths of these algae are called harmful algal blooms. When the prolific algal layer dies, it becomes oxygen-demanding waste, which can create very low O2 concentrations in the water (< 2 ppm O2), a condition called hypoxia. This results in a dead zone because it causes death from asphyxiation to organisms that are unable to leave that environment. An estimated 50% of lakes in North America, Europe, and Asia are negatively impacted by cultural eutrophication. In addition, the size and number of marine hypoxic zones have grown dramatically over the past 50 years including a very large dead zone located offshore Louisiana in the Gulf of Mexico. Cultural eutrophication and hypoxia are difficult to combat, because they are caused primarily by nonpoint source pollution, which is difficult to regulate, and N and P, which are difficult to remove from wastewater.

Pathogens are disease-causing microorganisms, e.g., viruses, bacteria, parasitic worms, and protozoa, which cause a variety of intestinal diseases such as dysentery, typhoid fever, and cholera. Pathogens are the major cause of the water pollution crisis discussed at the beginning of this section. Unfortunately nearly a billion people around the world are exposed to waterborne pathogen pollution daily and around 1.5 million children mainly in underdeveloped countries die every year of waterborne diseases from pathogens. Pathogens enter water primarily from human and animal fecal waste due to inadequate sewage treatment. In many underdeveloped countries, sewage is discharged into local waters either untreated or after only rudimentary treatment. In developed countries untreated sewage discharge can occur from overflows of combined sewer systems, poorly managed livestock factory farms, and leaky or broken sewage collection systems. Water with pathogens can be remediated by adding chlorine or ozone, by boiling, or by treating the sewage in the first place.

Oil spills are another kind of organic pollution. Oil spills can result from supertanker accidents such as the Exxon Valdez in 1989, which spilled 10 million gallons of oil into the rich ecosystem of coastal Alaska and killed massive numbers of animals. The largest marine oil spill was the Deepwater Horizon disaster, which began with a natural gas explosion at an oil well 65 km offshore of Louisiana and flowed for 3 months in 2010, releasing an estimated 200 million gallons of oil. The worst oil spill ever occurred during the Persian Gulf war of 1991, when Iraq deliberately dumped approximately 200 million gallons of oil in offshore Kuwait and set more than 700 oil well fires that released enormous clouds of smoke and acid rain for over nine months.

Groundwater pollution can occur from underground sources and all of the pollution sources that contaminate surface waters. Common sources of groundwater pollution are leaking underground storage tanks for fuel, septic tanks, agricultural activity, landfills, and fossil fuel extraction. Common groundwater pollutants include nitrate, pesticides, volatile organic compounds, and petroleum products. Another troublesome feature of groundwater pollution is that small amounts of certain pollutants, e.g., petroleum products and organic solvents, can contaminate large areas. In Denver, Colorado 80 liters of several organic solvents contaminated 4.5 trillion liters of groundwater and produced a 5 km long contaminant plume. A major threat to groundwater quality is from underground fuel storage tanks. Fuel tanks commonly are stored underground at gas stations to reduce explosion hazards. Before 1988 in the U.S. these storage tanks could be made of metal, which can corrode, leak, and quickly contaminate local groundwater. Now, leak detectors are required and the metal storage tanks are supposed to be protected from corrosion or replaced with fiberglass tanks. Currently there are around 600,000 underground fuel storage tanks in the U.S. and over 30% still do not comply with EPA regulations regarding either release prevention or leak detection.

(Retrieved from https://openoregon.pressbooks.pub/envirobiology/chapter/7-3-water-pollution/)

Text 15. The vanishing Aral Sea

The Aral Sea area, located on the border between Kazakhstan and Uzbekistan, was once the fourth largest inland sea in the world. Since the 1960s, water volume has been reduced. Tributary water to the Aral Sea derives from the rivers Amu Darya originating in Tajikistan, and Syr Darya originating in Kyrgyzstan. Early in the 20th century demand for river water to supply local agriculture, primarily the cotton industry, led to construction of irrigation systems. A highly inefficient system for water allocation combined with excessive resource exploration was the result. Subsequent failure to maintain infrastructure, in tandem with large emissions of pollutants have had serious consequences for people inhabiting the areas around the Aral Sea.

After the Soviet Union created collective farms in 1929, water usage increased and the Aral Sea started shrinking. By 1987, the lake had split into two separate parts. Water distribution was complicated by the collapse of the Soviet Union in 1991, creating several new countries with separate water policies. Uzbekistan is today one of the world's largest cotton producers and needs large amounts of water to sustain production. A simultaneous population increase complicates the severe water shortage in the area and contributes to the environmental disaster, evident by the disappearance of the Aral Sea. Its role as an important food source is impaired due to increased salinity. In 1983 more than 20 different fish species were declared extinct. River deltas have been replaced by desert, mediating a replacement of the original flora with hardier plants. Local climate change has occurred simultaneously with the disappearance of water. Formerly hot, humid regions are acquiring a cold, dry desert climate.

No rivers flow out of the Aral Sea; water disappears through evaporation. Before construction of the excessive irrigation systems, water level was kept stable by inflow from Amu Darya and Syr Darya. As human use of river water has increased, the composition of lake water has changed. Salt concentration has increased tenfold and local groundwater has a salt concentration reaching 6 g/L. This is six times higher than the concentration considered safe by WHO. Naturally, local inhabitants are exposed to saline water and in 2000 only 32 % had access to safe drinking water. An increased frequency of storms carries 43 million tons of dust and sand from the dried-out sea floor through the air yearly. Accordingly, the rate of dust deposition is among the highest in the world and contains large amounts of salts and pesticides, probably related to the water quality in the tributary rivers. Fertilisers, chlorinated organic pesticides and other chemicals are used in large quantities for agricultural purposes and pollutant-rich water returns to the rivers that supply the Aral Sea. Pollution also originates from the extensive mining industry in the area. Drain water contains heavy metals which flow into the rivers.

Global, regional and local climate change can have negative consequences for human health. The Aral Sea disaster shows the result of short-sighted human exploitation of nature and is an alarming signal, indicating that all human activities with potential climate effects must be carefully thought through.

(Retrieved from https://tidsskriftet.no/en/2017/10/global-helse/vanishing-aral-sea-health-consequences-environmental-disaster#ref1)

Text 16. Acid rain

Acid rain is a term referring to a mixture of wet and dries deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. The precursors, or chemical forerunners, of acid rain formation result from both natural sources, such as volcanoes and decaying vegetation, and man-made sources, primarily emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx) resulting from fossil fuel combustion. Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. The result is a mild solution of sulfuric acid and nitric acid. When sulfur dioxide and nitrogen oxides are released from power plants and other sources, prevailing winds blow these compounds across state and national borders, sometimes over hundreds of miles.

Acid rain is measured using a scale called "pH." The lower a substance's pH, the more acidic it is. Pure water has a pH of 7.0. However, normal rain is slightly acidic because carbon dioxide (CO2) dissolves into it forming weak carbonic acid, giving the resulting mixture a pH of approximately 5.6 at typical atmospheric concentrations of CO2. As of 2000, the most acidic rain falling in the U.S. has a pH of about 4.3.

Acid rain causes acidification of lakes and streams and contributes to the damage of trees at high elevations (for example, red spruce trees above 2,000 feet) and many sensitive forest soils. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. Prior to falling to the earth, sulfur dioxide (SO2) and nitrogen oxide (NOx) gases and their particulate matter derivatives—sulfates and nitrates—contribute to visibility degradation and harm public health.

The ecological effects of acid rain are most clearly seen in the aquatic, or water, environments, such as streams, lakes, and marshes. Most lakes and streams have a pH between 6 and 8, although some lakes are naturally acidic even without the effects of acid rain. Acid rain primarily affects sensitive bodies of water, which are located in watersheds whose soils have a limited ability to neutralize acidic compounds (called "buffering capacity"). Lakes and streams become acidic (i.e., the pH value goes down) when the water itself and its surrounding soil cannot buffer the acid rain enough to neutralize it. In areas where buffering capacity is low, acid rain releases aluminum from soils into lakes and streams; aluminum is highly toxic to many species of aquatic organisms. Acid rain causes slower growth, injury, or death of forests. Of course, acid rain is not the only cause of such conditions. Other factors contribute to the overall stress of these areas, including air pollutants, insects, disease, drought, or very cold weather. In most cases, in fact, the impacts of acid rain on trees are due to the combined effects of acid rain and these other environmental stressors.

Acid rain and the dry deposition of acidic particles contribute to the corrosion of metals (such as bronze) and the deterioration of paint and stone (such as marble and limestone). These effects significantly reduce the societal value of buildings, bridges, cultural objects (such as statues, monuments, and tombstones), and cars.

Sulfates and nitrates that form in the atmosphere from sulfur dioxide (SO2) and nitrogen oxides (NOx) emissions contribute to visibility impairment, meaning we cannot see as far or as clearly through the air. The pollutants that cause acid rain—sulfur dioxide (SO2) and nitrogen oxides (NOx)—damage human health. These gases interact in the atmosphere to form fine sulfate and nitrate particles that can be transported long distances by winds and inhaled deep into people's lungs. Fine particles can also penetrate indoors. Many scientific studies have identified a relationship between elevated levels of fine particles and increased illness and premature death from heart and lung disorders, such as asthma and bronchitis.

(Retrieved from https://openoregon.pressbooks.pub/envirobiology/chapter/10-3-acid-rain/)

Text 17. Sources of air pollution

A stationary source of air pollution refers to an emission source that does not move, also known as a point source. Stationary sources include factories, power plants, and dry cleaners. The term area source is used to describe many small sources of air pollution located together whose individual emissions may be below thresholds of concern, but whose collective emissions can be significant. Residential wood burners are a good example of a small source, but when combined with many other small sources, they can contribute to local and regional air pollution levels. Area sources can also be thought of as non-point sources, such as construction of housing developments, dry lake beds, and landfills.

A mobile source of air pollution refers to a source that is capable of moving under its own power. In general, mobile sources imply "on-road" transportation, which includes vehicles such as cars, sport utility vehicles, and buses. In addition, there is also a "non-road" or "off-road" category that includes gas-powered lawn tools and mowers, farm and construction equipment, recreational vehicles, boats, planes, and trains.

Agricultural sources arise from operations that raise animals and grow crops, which can generate emissions of gases and particulate matter. For example, animals confined to a barn or restricted area produce large amounts of manure. Manure emits various gases, particularly ammonia into the air. This ammonia can be emitted from the animal houses, manure storage areas, or from the land after the manure is applied. In crop production, the misapplication of fertilizers, herbicides, and pesticides can potentially result in aerial drift of these materials and harm may be caused.

Unlike the above mentioned sources of air pollution, air pollution caused by natural sources is not caused by people or their activities. An erupting volcano emits particulate matter and gases, forest and prairie fires can emit large quantities of "pollutants", dust storms can create large amounts of particulate matter, and plants and trees naturally emit volatile organic compounds which can form aerosols that can cause a natural blue haze. Wild animals in their natural habitat are also considered natural sources of "pollution".

Six common air pollutants. The most commonly found air pollutants are particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. These pollutants can harm health and the environment, and cause property damage. Of the six pollutants, particle pollution and ground-level ozone are the most widespread health threats.

Ground-level ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOC. Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. Ground level ozone can also have harmful effects on sensitive vegetation and ecosystems. (Ground-level ozone should not be confused with the ozone layer, which is high in the atmosphere and protects Earth from ultraviolet light; ground-level ozone provides no such protection).

Particulate matter, also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. The size of particles is directly linked to their potential for causing health problems. EPA is concerned about particles that are 10 micrometers in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

Carbon monoxide (CO) is a colorless, odorless gas emitted from combustion processes.Nationally and, particularly in urban areas, the majority of CO emissions to ambient air come from mobile sources. CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death.

Nitrogen dioxide (NO2) is one of a group of highly reactive gasses known as "oxides of nitrogen," or nitrogen oxides (NOx). Other nitrogen oxides include nitrous acid and nitric acid. EPA's National Ambient Air Quality Standard uses NO2 as the indicator for the larger group of nitrogen oxides. NO2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone, and fine particle pollution, NO2 is linked with a number of adverse effects on the respiratory system.

Sulfur dioxide (SO2) is one of a group of highly reactive gasses known as "oxides of sulfur." The largest sources of SO2 emissions are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of SO2 emissions include industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, large ships, and non-road equipment. SO2 is linked with a number of adverse effects on the respiratory system.

Lead is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been from fuels in on-road motor vehicles (such as cars and trucks) and industrial sources. As a result of regulatory efforts in the U.S. to remove lead from on-road motor vehicle gasoline, emissions of lead from the transportation sector dramatically declined by 95 percent between 1980 and 1999, and levels of lead in the air decreased by 94 percent between 1980 and 1999. Today, the highest levels of lead in air are usually found near lead smelters. The major sources of lead emissions to the air today are ore and metals processing and piston-engine aircraft operating on leaded aviation gasoline.

(Retrieved from https://openoregon.pressbooks.pub/envirobiology/chapter/10-1-atmospheric-pollution/)

Text 18. Environmental concerns with wastes

An enormous quantity of wastes are generated and disposed of annually. Alarmingly, this quantity continues to increase on an annual basis. Industries generate and dispose over 7.6 billion tons of industrial solid wastes each year, and it is estimated that over 40 million tons of this waste is hazardous. Nuclear wastes as well as medical wastes are also increasing in quantity every year.

A wide variety of chemicals are present within waste materials, many of which pose a significant environmental concern. Though the leachate generated from the wastes may contain toxic chemicals, the concentrations and variety of toxic chemicals are quite small compared to hazardous waste sites. For example, explosives and radioactive wastes are primarily located at Department of Energy (DOE) sites because many of these facilities have been historically used for weapons research, fabrication, testing, and training. Organic contaminants are largely found at oil refineries, or petroleum storage sites, and inorganic and pesticide contamination usually is the result of a variety of industrial activities as well as agricultural activities. Yet, soil and groundwater contamination are not the only direct adverse effects of improper waste management activities – recent studies have also shown that greenhouse gas emissions from the wastes are significant, exacerbating global climate change.

A wide range of toxic chemicals, with an equally wide distribution of respective concentrations, is found in waste streams. These compounds may be present in concentrations that alone may pose a threat to human health or may have a synergistic/cumulative effect due to the presence of other compounds. Exposure to hazardous wastes has been linked to many types of cancer, chronic illnesses, and abnormal reproductive outcomes such as birth defects, low birth weights, and spontaneous abortions. Many studies have been performed on major toxic chemicals found at hazardous waste sites incorporating epidemiological or animal tests to determine their toxic effects.

As an example, the effects of radioactive materials are classified as somatic or genetic. The somatic effects may be immediate or occur over a long period of time. Immediate effects from large radiation doses often produce nausea and vomiting, and may be followed by severe blood changes, hemorrhage, infection, and death. Delayed effects include leukemia, and many types of cancer including bone, lung, and breast cancer. Genetic effects have been observed in which gene mutations or chromosome abnormalities result in measurable harmful effects, such as decreases in life expectancy, increased susceptibility to sickness or disease, infertility, or even death during embryonic stages of life. Because of these studies, occupational dosage limits have been recommended by the National Council on Radiation Protection. Similar studies have been completed for a wide range of potentially hazardous materials. These studies have, in turn, been used to determine safe exposure levels for numerous exposure scenarios, including those that consider occupational safety and remediation standards for a variety of land use scenarios, including residential, commercial, and industrial land uses.

The chemicals found in wastes not only pose a threat to human health, but they also have profound effects on entire eco-systems. Contaminants may change the chemistry of waters and destroy aquatic life and underwater eco-systems that are depended upon by more complex species. Contaminants may also enter the food chain through plants or microbiological organisms, and higher, more evolved organisms bioaccumulate the wastes through subsequent ingestion. As the contaminants move farther up the food chain, the continued bioaccumulation results in increased contaminant mass and concentration. In many cases, toxic concentrations are reached, resulting in increased mortality of one or more species. As the populations of these species decrease, the natural inter-species balance is affected. With decreased numbers of predators or food sources, other species may be drastically affected, leading to a chain reaction that can affect a wide range of flora and fauna within a specific eco-system. As the eco-system continues to deviate from equilibrium, disastrous consequences may occur. Examples include the near extinction of the bald eagle due to persistent ingestion of DDT-impacted fish, and the depletion of oysters, crabs, and fish in Chesapeake Bay due to excessive quantities of fertilizers, toxic chemicals, farm manure wastes, and power plant emissions.

(Retrieved from https://www.ck12.org/user:zg9yc25lckbnbwfpbc5jb20./book/essentials-of-environmental-science/section/15.1/)

Glossary of environmental terms

Abiotic	*adj.*	not involving biology or living things
Acid	*adj.*	a chemical, usually a liquid that contains hydrogen and has a pH of less than seven
Albedo	*n.*	the ration of the planet solar radiation reflected to the outer space, to the solar radiation which reaches the boarder of the atmosphere
Algae	*n.*	very simple plants that have no real leaves, stems or roots, and that grow in or near water
Alpine	*adj.*	existing in or connected with high mountains, especially the Alps in Central Europe
Altitude	*n.*	the height above sea level
Aquifer	*n.*	a layer of rock or soil that can take in and hold water
Anthropogenic	*adj.*	indicating that something is human-caused
Arid	*adj.*	having little or no rain; very dry
Atmosphere	*n.*	a gaseous layer enveloping the earth
Backbone	*n.*	the row of small bones that are connected together down the middle of the back
Bay	*n.*	a part of the sea, or of a large lake, partly surrounded by a wide curve of the land
Bedrock	*n.*	the solid rock in the ground below the loose soil and sand
Biodiversity	*n.*	the existence of a large number of different kinds of animals and plants which make a balanced environment
Biome	*n.*	the characteristic plants and animals that exist in a particular type of environment, for example in a forest or desert
Biosphere	*n.*	the part of the earth's surface and atmosphere in which plants and animals can live
Biotic	*adj.*	of or related to living things
Boreal	*adj.*	describing or relating to the climate zone south of the Arctic

Carnivore	*n.*	any animal that eats meat
Celestial	*adj.*	of the sky or of heaven
CFC	*n.*	a type of gas previously used especially in aerosols, harmful to the earth's ozone layer and is generally no longer used in these products. (the abbreviation for 'chlorofluorocarbon')
Clam	*n.*	a shellfish that can be eaten. It has a shell in two parts that can open and close
Contamination	*n.*	the process or fact of making a substance or place dirty or no longer pure by adding a substance that is dangerous or carries disease
Core	*n.*	the central part of an object
Crust	*n.*	the outer layer of rock that forms the surface of the earth or another planet
Dam	*n.*	a barrier that is built across a river in order to stop the water from flowing, used especially to make a reservoir or to produce electricity
Deforestation	*n.*	the act of cutting down or burning the trees in an area
Depletion	*n.*	the result of the extraction of abiotic resources (non-renewable) from the environment or the extraction of biotic resources (renewable) faster than they can be renewed
Desert	*n.*	a large area of land that has very little water and very few plants growing on it. Many deserts are covered by sand
Drought	*n.*	a long period of time when there is little or no rain
Earthquake	*n.*	a sudden, violent shaking of the earth's surface
Ecosystem	*n.*	all the plants and living creatures in a particular area considered in relation to their physical environment
Emission	*n.*	one or more substances released to the water, air or soil in the natural environment
Environment	*n.*	the natural world in which people, animals and plants live

Erosion	*n.*	the process by which the surface of something is gradually destroyed through the action of wind, rain, etc.
Eruption	*n.*	an occasion when a volcano suddenly throws out burning rocks, smoke, etc.
Eutrophication	*n.*	the process of too many plants growing on the surface of a river, lake, etc., often because chemicals that are used to help crops grow have been carried there by rain
Evaporation	*n.*	the process of a liquid changing or being changed into a gas
Exosphere	*n.*	
Fertilizer	*n.*	a substance added to soil to make plants grow more successfully
Flood	*n.*	a large amount of water covering an area that is usually dry
Forest floor	*n.*	the above-ground layer of a forest made up of tree roots, soil and decaying matter
Fossil fuel	*n.*	fuel such as coal or oil that was formed over millions of years from parts of dead animals or plants
Fungus (pl. **fungi**)	*n.*	a plant that has no flowers, leaves, or green colouring, such as a mushroom or a toadstool
Glacier	*n.*	an extremely large mass of ice which moves very slowly, often down a mountain valley
Groundwater	*n.*	water that is found under the ground in soil, rocks, etc.
Gulf	*n.*	a large area of sea that is partly surrounded by land
Habitat	*n.*	the place where a particular type of animal or plant is normally found
Hemisphere	*n.*	one half of the earth, especially the half above or below the equator
Herbivore	*n.*	any animal that eats only plants
Humidity	*n.*	the amount of water in the air
Hydrosphere	*n.*	all of the water on or over the earth’s surface

Ice sheet	*n.*	a layer of ice that covers a large area of land for a long period of time
Irrigation	*n.*	the practice of supplying water to an area of land through pipes or channels so that crops will grow
Landscape	*n.*	everything you can see when you look across a large area of land, especially in the country
Longitude	*n.*	the distance of a place east or west of the Greenwich meridian, measured in degrees
Latitude	*n.*	the distance of a place north or south of the equator (= the line around the world dividing north and south), measured in degrees
Livestock	*n.*	the animals kept on a farm, for example cows or sheep
Lead	*n.*	naturally-occurring element found in the air, soil, water, and the earth's crust that is very toxic if it enters the body at high levels; commonly inhaled as dust, fumes, or mist which then enters the bloodstream and is stored in the bones
Mammal	*n.*	any animal that gives birth to live young, not eggs, and feeds its young on milk
Mantle	*n.*	the part of the earth below the crust and surrounding the core
Manure	*n.*	the waste matter from animals that is spread over or mixed with the soil to help plants and crops grow
Marine	*adj.*	connected with the sea and the creatures and plants that live there
Marsh	*n.*	an area of low land that is always soft and wet because there is nowhere for the water to flow away to
Mesosphere	*n.*	the part of the earth's atmosphere between the stratosphere and the thermosphere in which temperature decreases with altitude to the atmosphere's absolute minimum
Methane	*n.*	a colorless, odorless, nontoxic, and flammable gas that is the

		main component of natural gas
Moisture	*n.*	very small drops of water or other liquid that are present in the air, on a surface or in a substance
Mussel	*n.*	a small shellfish that can be eaten, with a black shell in two parts
Nitrogen	*n.*	a chemical element, a gas that is found in large quantities in the earth’s atmosphere
Nucleus (pl. **nuclei**)	*n.*	the central part of some cells, containing the genetic material
Nutrient	*n.*	a substance that is needed to keep a living thing alive and to help it to grow
Offspring	*n.*	a child of a particular person or couple; the young of an animal or plant
Ozone	*n.*	a gaseous atmospheric substance that protects the Earth's surface from harmful UV radiation
Oxygen	*n.*	a gas that is present in air and water and is necessary for people, animals and plants to live
Particulate matter	*n.*	the sum of all solid and liquid particles suspended in air, many of which are hazardous
Pasture	*n.*	land covered with grass that is suitable for feeding animals on
Peat	*n.*	a soft black or brown substance formed from old or dying plants just under the surface of the ground, especially in cool wet areas. It is burned as a fuel or used to improve garden soil
Pedosphere	*n.*	the outermost layer or "skin" of the Earth, subject to soil formation processes
Permafrost	*n.*	a layer of soil that is permanently frozen, in very cold regions of the world

Pole	*n.*	either of the two points at the opposite ends of the line on which the earth or any other planet turns
Pollen	*n.*	fine powder, usually yellow, that is formed in flowers and carried to other flowers of the same kind by the wind or by insects, to make those flowers produce seeds
Pollutant	*n.*	a substance that pollutes something, especially air and water
Pollution	*n.*	residual discharges of emissions to the air or water following application of emission control devices
Pond	*n.*	a small area of still water, especially one that is artificial
Prairie	*n.*	a flat, wide area of land in North America and Canada, without many trees and originally covered with grass
Precipitation	*n.*	rain, snow, etc. that falls; the amount of this that falls
Predator	*n.*	an animal that kills and eats other animals
Prey	*n.*	an animal, a bird, etc. that is hunted, killed and eaten by another
Reef	*n.*	a long line of rocks or sand near the surface of the sea
Rock	*n.*	the hard solid material that forms part of the surface of the earth and some other planets
Salinity	*n.*	the fact of containing salt; the amount of salt contained in something
Schist	*n.*	a type of rock formed of layers of different minerals, that breaks naturally into thin flat pieces
Seaweed	*n.*	a plant that grows in the sea, or on rocks at the edge of the sea. There are many different types of seaweed, some of which are eaten as food
Sediment	*n.*	solid fragmental material that originates from weathering of rocks and is transported or deposited by air, water, or ice; accumulates by other other natural agents such as chemical precipitation from solution or secretion by organisms; forms

		in layers; includes sand, gravel, silt, mud, till, loess, and alluvium
Sewage	*n.*	used water and waste substances that are produced by human bodies, that are carried away from houses and factories through special pipes
Shale	*n.*	a type of soft stone that splits easily into thin flat layers
Slate	*n.*	a type of dark grey stone that splits easily into thin flat layers
Snowpack	*n.*	a mass of snow that has been pressed down so that it forms a hard layer
Soil	*n.*	unconsolidated materials above bedrock
Solar	*adj.*	of or connected with the sun
Species (pl. **species**)	*n.*	a group into which animals, plants, etc. that are able to have sex with each other and produce healthy young are divided, smaller than a genus and identified by a Latin name
Sulphur	*n.*	a chemical element, a pale yellow substance that produces a strong unpleasant smell when it burns and is used in medicine and industry
Sustainability	*n.*	the use of natural products and energy in a way that does not harm the environment
Terrestrial	*adj.*	living on the land or on the ground, rather than in water, in trees or in the air
Tide pool	*n.*	a small amount of water that collects between the rocks by the sea
Topography	*n.*	detailed description or representation on a map of the natural and artificial features of an area
Troposphere	*n.*	the lowest layer of the earth's atmosphere, between the surface of the earth and about 6–10 kilometres above the surface
Tundra	*n.*	the large, flat Arctic regions of northern Europe, Asia and

		North America where no trees grow and where the soil below the surface of the ground is always frozen
Vapor	*n.*	a mass of very small drops of liquid in the air, for example steam
Watershed	*n.*	an area of land that catches rain or snow
Wetland	*n.*	an area where a surface is flooded for an extended period of time or where the soil is saturated by groundwater that moves or stays close to the surface

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