UČEBNÍ TEXTY UNIVERZITY KARLOVY

ENGLISH FOR PHARMACY AND MEDICAL BIOANALYTICS

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KAROLINUM

English for Pharmacy and Medical Bioanalytics

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CONTENTS

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PREFACE

This textbook is mainly intended for a four-semester university course both in bachelor and master programs of Pharmacy and Medical Bioanalytics. It is also suitable for users working in pharmacy and related professions.

The book provides a selection of topics that users can find useful at work as well as in their further studies and research activities. The problems of chemistry, pharmacology, biology and medicine are covered. Apart from more theoretical topics, users will also find chapters focused on practical problems they can come across in everyday professional life, usually comparing the Czech pharmaceutical and health-care system to those of some English speaking countries, mainly Great Britain and the USA. There are also included chapters focused on doctor-patient situations as well as effective pharmacist-patient communication. Two final chapters are dedicated to practical issues of job application, Curriculum Vitae, and presentation of one's professional qualities.

The goal of this textbook is to make users acquainted with contemporary and topical vocabulary and problems of pharmaceutical and health-care professions and to provide them with a sound knowledge and a good background for successful reading and communication in English.

The textbook is recommended for users who already have at least intermediate knowledge of English as well as knowledge in the special fields covered in the book.

The textbook is suitable for both classroom use and self-study.

All chapters follow the same format. Each chapter opens with a brief text introducing the topic and related vocabulary. This part of the chapter is followed by exercises meant to practice the vocabulary and sentence structures used in the opening article. The exercises which follow are not only theoretic questions but are also directed towards practical applications. There is a number of conversational exercises, which, under a teacher's supervision hope to enhance students' communication skills and encourage their confidence in using spoken English.

At the end of the chapters users will find a Czech to English translation exercises enabling them to check the knowledge gained in each of the chapters. Grammatical exercises are used as a supplementary part focused on the revision of some of the more advanced grammatical features.

The textbook is equipped with a practical English to Czech dictionary where users will find the specialist vocabulary used in the book.

The authors hope that this textbook will help users to strengthen their existing knowledge as well as gain new information employable in their professional lives.

Authors

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UNIT 1

THE FACULTY OF PHARMACY AND THE COURSE OF STUDY

1.1 History of the Education of Pharmacy

The Prague pharmacists were connected with Charles University from its foundation. They were under the professional supervision of the Rector of Charles University and the Dean and professors of the Faculty of Medicine. There was a one-year pharmacy course, and from 1834 a two-year course. They studied at more than one faculty: at the Faculty of Arts, and the Faculty of Natural Sciences; but the end of their study was always held at the Faculty of Medicine. From 1948 there was a four-year course, but it was cancelled in 1950 and transferred to Masaryk University in Brno. It led to the establishment of the Faculty of Pharmacy in Brno and Bratislava in 1952.

The Faculty of Pharmacy, with its seat in the town of Hradec Králové, was established by a government decree in 1969. The Faculty of Pharmacy has continued in the old and long-time tradition of the education of pharmacy at Charles University.

1.2 Undergraduate Study

The academic year begins on October 1st and it consists of the winter and summer terms/semesters. Each term/semester consists of fourteen weeks of classes which are followed by a four to five week examination period. At present, the course of undergraduate study at the Faculty of Pharmacy takes five years. The programme for undergraduate study makes it possible for students to specialize adequately according to their interests by choosing from recommended and optional subjects besides the compulsory disciplines. It is compulsory to take part in the practical laboratory training and to get through practical placements in pharmacies and other pharmaceutical institutions during the course of studies.

Their knowledge of the subjects is proven by taking examinations to fulfil the required scientific profile of the graduate. The course of studies is concluded by passing the Final State Examinations and by the successful defence of an undergraduate's degree paper. Finally, the graduate is awarded the academic degree of Magister (Mgr.) at the graduation ceremony.

The concept of the programme corresponds with the contemporary state and standard of pharmaceutical sciences, the needs of the pharmaceutical practice in the European context, and it creates a base for postgraduate studies, the course of study that enables one to yield deeper scientific education in a special branch.

1.3 Postgraduate (Doctoral) Studies

Graduates of the studies of pharmacy or of some related discipline (e.g., Faculty of Medicine or Natural Sciences) can apply for admission to the three-year internal or five-year external course of postgraduate doctoral studies. The conditions for admission to postgraduate study are the successful completion of the entrance examination, and at least one professional publication.

The PhD studies involve scientific work in a selected research project under the supervision of distinguished teachers of the Faculty of Pharmacy. The postgraduate course of studies is completed by passing examinations in theoretical topics related to the appropriate research project, and by writing and defending a doctoral dissertation. The Accreditation Committee of the Government of the Czech Republic approved the following fields in which it is possible to obtain the academic scientific degree of Doctor (PhD) at the

Faculty of Pharmacy, Charles University: *Bioorganic Chemistry, Drug Control, Clinical Pharmacy, Gerontopharmacy, Pathobiochemistry and Xenobiochemistry, Pharmacology and Toxicology, Pharmacognosy, Pharmaceutical Chemistry, Pharmaceutical Technology, Social Pharmacy, and Pharmacy Practice*.

1.4 Executive and Management

• Executive Committee
At present the Executive Committee of the faculty consists of the Dean, four Vice-Deans (pedagogical activities, science and research, international relations), and an economic secretary.

• Dean of Faculty
The head of the faculty is the Dean. The official title of Dean used during ceremonies is "Spectabilis". The Dean is elected for a period of three years by the Academic Senate. The function of the Dean is not only symbolic but he is also the head of the Executive Committee, and together with the Academic Senate has the highest responsibility for the faculty's prosperity.

• Scientific Council
The most important advisory body of the Dean is the Scientific Council, which is created by the Dean of the faculty and consists of professors and associate professors of the faculty and of outstanding specialists from the institutes outside the faculty. The Scientific Council deals with problems concerning the concept of the educational and scientific activities of the faculty.

• Academic Senate
The Academic Senate is established in a democratic way. The members of the Academic Senate are elected for a period of three years by the members of the academic community of the faculty (the students and graduate employees of the faculty). The Academic Senate consists of twenty-two members (thirteen teachers and nine students). The Academic Senate has mainly a controlling function.

• Accommodation for Students
The total number of students of the Faculty of Pharmacy in Hradec Králové is almost one thousand. The faculty has Halls of Residence which are very close to the faculty buildings, just a ten-minute walk. The halls represent a wide complex of study facilities, furnished rooms, refectory, club, sports centre, and more.

Exercises

1. Text comprehension.

a) Finish the following sentences:

1. From 1834 to 1950 students of pharmacy used to study at ……
   …… in …….
2. From 1950 to 1952 they used to study at …… …… in …….
3. From 1952 to 1969 they used to study at the Faculties of Pharmacy in …… and
   ……
4. In …… the Faculty of Pharmacy in Hradec Králové was established.

b) Read the first two paragraphs again and find synonyms.

establishment	……	elective (AmE)	…… (BrE)
placement	……	obligatory	……
licence	……	to be finished	……
to keep on	……	student of university	……
nowadays	……	lastly	……

to last	……	to be conferred a title	……
to render possible	……	to be up to	……
sufficiently	……	requirements	……

c) Answer the following questions.

1. What courses are students obliged to attend during their studies?
2. How is their acquired knowledge checked?
3. What will they finish their university studies with?
4. What degree will be conferred on them and where?
5. What kind of study can they apply for after graduation?
6. What does the postgraduate study programme involve?
7. What is the PhD study finished with?
8. Out of how many fields can they choose the topic for research and dissertation?
9. Who have the fields been approved by?

d) Decide whether the following sentences are true or false. Justify your answers.

1. The Executive Committee of the faculty is composed of the Dean, a Vice-Dean and an economic secretary.
2. Students use the official title of the Dean during their course of study.
3. The Academic Senate elects the Dean for a period of three years.
4. Not only the Dean is responsible for the prosperity of the faculty.
5. The professors of the faculty create the Scientific Council.
6. The Scientific Council is concerned with the research and other scientific activities of the faculty.
7. The Academic Senate is the most important advisory body of the Dean.
8. The Academic Senate is elected by students and professors of the faculty.
9. There are nine teachers and thirteen students in the Academic Senate.

2. Check your vocabulary.
Guess the missing words. The first letters should help you.

1. A s …… lists the times of classes, lectures, etc.
2. Students who live in a dormitory at a college are called b …….
3. The head of a college could be called a p …….
4. The function of a school is to e …… children.
5. Have you seen the new s …… for the exams?
6. Some students learn languages with e …….
7. School children receive a r …… at the end of each term.
8. Not all applicants can be a …… to the university if they pass the e…… tests.
9. Before an exam students always r …… what they have learnt.
10. Each exam at our college requires a deep k …….

3. Read the following quotations and explain the meaning.

1. *Education is what survives when what has been learned has been forgotten.*
   ~ B. F. Skinner
2. *Graduation is not the end; it's the beginning.*
   ~ Orrin Hatch
3. *Put your future in good hands – your own.*
   ~ Author Unknown
4. *It is not the mountain we conquer but ourselves.*
   ~ Edmund Hillary

4. Read the short text and explain each of the expressions printed in bold.
Study and Exams

Before an exam you can **revise** or **cram** for it. Some things can be **memorised**. It is also possible to use **mnemonics**. But the best idea is to **bury yourself in your books** until you **know the subject inside out**.

5. Complete the text with the words from the box and explain or translate their meaning.

drop out	**inter-library loan**	**finals**	**carry out**
demanding	**papers/articles**	**cope**	**academic**

Aspects of higher academic study
University academics 1. …… research and are expected to read 2. …… journals, which publish 3. …… on specialised subjects. If a library does not have a book or journal, you can usually get it through 4. ……. Academic study can be very 5. …… and intensive, and students sometimes 6. …… of the course because they cannot 7. ……., but the majority survive till the 8. …….

6. There is one idiomatic expression concerning studies and exams in each sentence. Underline it and choose the right meaning.

1. It's very easy to fall behind in your studies if you miss even just a few classes.
   a) stay close behind other students
   b) find yourself far behind other students
   c) get ahead of other students
2. She seemed to just breeze through the exams. Everyone else was in such a panic and almost had nervous breakdowns.
   a) do them calmly and efficiently
   b) not take them seriously
   c) cheat in them
3. I just can't seem to get the hang of English prepositions. Just when I think I've learnt them I make new mistakes.
   a) memorise b) understand c) enjoy
4. When I sat down and looked at the exam paper my mind just went blank. Everyone else seemed to be writing away quite happily.
   a) became confused b) became very focused c) became empty

7. Read the poem.
Each of us must climb our separate mountain
written by William Byrd

Each of us must climb our separate mountain
To reach at last our own extended view.
We can be no more than what we are,
Yet that is quite enough for us to do.

And so we're proud of each of you today
For all you've learned, and all you've tried to learn.
Knowledge brings the deepest satisfaction,
Not least because it's something that you earn.

Now answer the following questions.

1. What occasion could the poem be referring to?
2. Who could these words be spoken by?
3. Who would this poem be directed to?

8. Check your grammar.
Do you remember?

a) Suggestion and Advice	***had better (’d better)*** ***should*** ***ought to***

Note: Combines suggestion and advice. Conveys the idea ***it would be advisable or right to***.

Example: *You**’d better (should/ought to)** spend more time revising if you want to pass the exam.*

1. I think we should leave at once or we’ll be late.
2. If I were you, I would study harder.
3. I suggest listening to our parents’ advice.
4. I shouldn’t believe a word he says if I were you.
5. Working at the computer all the time is bad for you. You should get some rest.

b) Advice	***worth +… ing***

Example: It’s ***worth learning*** languages.

1. Don’t worry about her. She’s not worth it.
   She’s not …
   or It’s not worth …
2. Pharmacy is a very interesting branch of medical science. You should study it.
3. Remember to take some notes with you. It could be useful.
4. The book is exciting to read.
5. It makes no sense to talk about it. We can’t solve it anyway.

9. Let’s laugh a little!
I will do anything to pass.

A student comes to a young professor’s office hours. She glances down the hall, closes his door, kneels pleadingly.
“I would do anything to pass this exam.” She leans closer to him, flips back her hair, gazes meaningfully into his eyes. “I mean ...” she whispers,“... I would do ... anything.”
He returns her gaze. “Anything?”
“Anything.”
His voice softens. “Anything??”
“Absolutely anything.”
His voice turns to a whisper. “Would you ... study?”

10. Translate.

1. Studijní program Farmacie je magisterské pětileté studium, zakončené státní závěrečnou zkouškou a obhajobou diplomové práce.

2. Výuka každého povinného nebo volně volitelného předmětu je uzavřena na konci semestru zápočtem nebo zápočtem a zkouškou, případně jen zkouškou.
3. Předmět může být uskutečňován v podobě přednášky, cvičení, semináře, kurzu, praxe, stáže, laboratorní práce, exkurze, samostatné práce nebo konzultace.
4. Laboratorní cvičení a praktika tvoří přibližně dvě třetiny studijního programu, zbytek připadá na přednášky a semináře.
5. Lékárník musí mít důkladné znalosti o všech lécích a měl by být schopen pacientům vše potřebné podrobně vysvětlit.
6. Farmaceut by měl umět alespoň jeden světový jazyk, aby mohl sledovat zahraniční odbornou literaturu.
7. Očekává se, že vystudovaní farmaceuti budou i nadále číst vědecké časopisy a účastnit se dalších vzdělávacích programů.
8. Absolvent se může také ucházet o přijetí do tříleté prezenční formy nebo obvykle pětileté kombinované formy doktorského studia.
9. Doktorské studium končí vypracováním a obhájením disertační práce, vykonáním státní doktorské zkoušky a udělením titulu doktor (Ph.D.).
10. Vysokoškolsky vzdělaný farmaceut má znalosti o léčivech a léčivých přípravcích, o látkách užívaných při jejich přípravě, o účinku léčivých látek, o pravidlech užití léčiv, o působení toxických látek atd.

UNIT 2

CHEMISTRY

Chemistry studies elements, their reactions, and interactions. All matter is created from elements. Therefore, chemistry is also concerned with matter, its structure, composition, and properties. It deals with the ways it is formed and changed.

2.1 Different Types of Matter

• Mixtures

A mixture consists of two or more substances mixed together in variable amounts. It is usually possible to separate the mixture back in to its individual components. Much of the matter we come across in our lives exists in the form of mixtures (e.g. fuels, foods, and drinks) Also, our bodies are very complicated mixtures of many individual substances.

• Chemical Elements

A chemical element is a material composed of only one type of atom that cannot be separated into simpler substances and that singly or in combination constitute all matter. In total, 117 have been observed as of 2007. 94 of these fundamental building blocks occur naturally on the Earth. The rest of the elements have been discovered as products of artificial nuclear reactions. Each element has its own symbol established by international agreement.

The elements are arranged in the ***Periodic Table***, the invention of which is generally attributed to the 19th century Russian chemist **Dimitri Mendeleev**. The layout of the table is based on his observations and reflects the recurring chemical and physical properties of the sixty-six then known elements. It is a very practical tool for organising all the known elements of the universe.

• Chemical Compounds

A compound is a chemically pure substance composed of two or more elements in a constant composition and combination. Researches have isolated, identified and characterised more than 15 million chemical compounds. Among these are some of the most familiar naturally occurring substances, including water, salt, and sugar. Nevertheless, most known compounds have been synthesised by chemists. The composition of a compound, its physical properties (such as boiling point), and chemical reactivity are fixed.

2.2 Atoms and Molecules

It is well-known that elements are comprised of **atoms**. An atom is the smallest indivisible (i.e. cannot be broken down) unit of matter that can exist as an independent entity. Atoms are miniscule objects which are many billions of times smaller than anything we can notice with our eyes. In order to see it we need special devices. Each element is created by its own specific combination of atoms. As it has already been mentioned compounds are composed of the atoms of two or more elements. For instance, the compound carbon dioxide has a ratio of two oxygen atoms for every carbon atom. Its symbolic representation is CO_2. This is an example of a **chemical formula**, which represents the elementary composition of chemical compounds.

Not only carbon dioxide but also millions of other compounds exist in **molecules**. A molecule is a combination of a fixed number of atoms, held together in a certain geometric arrangement. Hence, one molecule of carbon dioxide consists of one carbon atom bound to two oxygen atoms.

2.2.1 Atomic Structure

Despite the fact that an atom is an indivisible entity it has its own structure. However, if we try to break it down into smaller particles, it loses its chemical properties. A nucleus, which consists of particles called protons and neutrons, lies in the centre of every atom. Both particles are large and heavy, with the former being positively charged and the latter electrically neutral. Electrons, which are beyond the nucleus and define the outer boundary of the atom, carry negative electrical charges. They are extremely tiny and very light with about $1/2000^{th}$ the mass of a proton or neutron. If an atom is electrically neutral, the number of electrons equals the number of protons. We call this number the **atomic number**. Each element has its own atomic number. For example, hydrogen equals 1, helium 2 and so on.

2.2.2 Isotopes

Isotopes can be defined as two or more forms of the same element whose atoms have the same number of protons but differ in number of neutrons. That is why the isotopes have different **mass numbers** (the sum of the number of protons and neutrons in an atomic nucleus). Helium exists as helium-3 or He-3 (reflecting the fact that its nucleus contains 2 protons but only 1 neutron) or as helium-4 or He-4 (2 protons and 2 neutrons). These two examples are called isotopes of helium. *Deuterium*, a naturally occurring isotope of hydrogen, is assigned a mass number of 2 because it contains one proton and one neutron. *Tritium*, a third radioactive isotope of hydrogen, has two neutrons and one proton. Therefore, it has a mass number of 3. Tritium does not normally appear in nature. Identifying isotopes we add the mass number after the name or symbol of the element. Thus, tritium is designated as hydrogen-3 or H-3.

2.3 Types of Chemical Bonds

• Covalent Bonds

They result when atoms share one or more pairs of electrons. There are two types of covalent bonds; *polar* and *non-polar*. The latter bonds are formed when electrons are equally distributed between the two atoms. However, the former one arises between two different atoms. The polar covalent bond may cause the electrons to be pulled more toward one atom than the other. The end of the molecule toward which the electrons are pulled is electrically negative compared to the other end.

• Ionic Bonds

Normally, atoms are neutral and have no charge. Nevertheless, in order to gain stability they either lose one or more electrons, thus becoming a positive ion (*cation*), or they gain one or more electrons thus becoming a negative ion (*anion*). When this happens the resulting charged atoms attract each other. That electrical attraction between two oppositely charged ions is referred to as an ionic bond. As the electrons are completely transferred to a second atom they are not shared at all.

• In addition, a **single** (sharing only a pair of electrons), a **double** (sharing two pairs of electrons) or a **triple bond** (sharing three pairs of electrons) can form.

2.4 Water

Thanks to its polarity water is the universal solvent. It boils at 100°C and freezes at 0°C. As it heats and freezes slowly, it remains liquid at the temperature of living beings. Pure water has a neutral pH. Acids cause a higher hydrogen ion concentration and thus lower the pH, whereas bases decrease the hydrogen ion concentration and thus increase its pH.

2.5 Composition of Air

Joseph Priestley, the British chemist, contributed greatly to the study of gases. He is most often credited for his discovery of oxygen, which happened in 1774 (three years before it was independently found by *Carl Scheele*). Priestley found that oxygen forms about one-fifth of air. The other four-fifths of air mostly consist of nitrogen, which was discovered in 1772 by the Scottish physician *Daniel Rutherford*. In 1756 another Scottish man named *Joseph Black* discovered carbon dioxide which also occurs in variable amounts in air. He was a chemist and a doctor.

British chemist *Henry Cavendish* also studied gasses. In 1776 Cavendish discovered hydrogen. In 1781 he demonstrated that air is composed mainly of a mixture of nitrogen and oxygen. Two years later he confirmed that the atmosphere sampled at various locations always has the same composition.

2.6 Biomolecules

Biomolecules are naturally occurring molecules in a living organism. They are composed of carbon and hydrogen as well as nitrogen, oxygen, phosphorus, and sulphur.

• Carbohydrates
Carbohydrates are a large class of organic compounds that include sugars, starches, and celluloses. They serve as the main energy source in the diet of animals. They play major roles in the processes of the immune system, fertilization, blood clotting, and development. They are produced in green plants during photosynthesis.

• Lipids
Lipids include fats, oils, waxes, cholesterol, fat-soluble vitamins, and others. They store energy, act as structural components of cell membranes, and function as important signalling molecules that are lipid messengers which bind to and activate a receptor. Many lipids are indispensable for our lives. However, abnormal levels (e.g. cholesterol) can lead to number of diseases.

• Proteins
Proteins consist of amino acids arranged in a linear chain and connected by peptide bonds. They are involved in the processes within cells. They are enzymes which function as catalysts of biochemical reactions. Also, they play a crucial role in structural and mechanical functions. They are indispensable for cell signalling, immune responses, animals' diet, and so on.

• Nucleic acids
Nucleic acids comprise the chains of nucleotides. The two most common examples are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). The former stores the genetic information and carries the instructions which are used for construction of other cell components. The latter sends messages between DNA and ribosomes and carries amino acids which are to be used in protein synthesis.

2.7 Reactions and Equations

A **chemical reaction** *is a process whereby substances described as* ***reactants*** *are transformed into different substances called* ***products***. *The process can be represented by an expression called a* ***chemical equation***. [Chemistry in Context, p. 16]

By an international agreement the reactant(s) are to be stated on the left whereas the products should be written on the right:

$$\text{Reactant(s)} \rightarrow \text{Product(s)}$$

An arrow in the middle is a symbol of a chemical change which is commonly read as "*is converted to*" or "*yields*". Therefore we can say that one or more products, which are substantially different from the starting reactant(s), are yielded or converted in a chemical reaction.

An example of a simple reaction can be a combustion during which carbon and oxygen are converted to carbon dioxide. This reaction can be represented either by a *word equation* (1) or by *chemical symbols* and *formulas* (2). The latter one is used more often.

(1) Carbon + Oxygen → Carbon dioxide

(2) $C + O_2 \rightarrow CO_2$

Reading the above equation may sound something like this: *One atom of the element carbon reacts with one molecule of the element oxygen (consisting of two oxygen atoms bonded to each other) to yield one molecule of the compound carbon dioxide (consisting of one carbon atom bonded to two oxygen atoms).* [Chemistry in Context, p. 17]

The equation needs to be balanced. The coefficients must be added before the symbols and formulas (3).

(3) $2\ C + O_2 \rightarrow 2\ CO_2$

Exercises

1. Fill in the appropriate word.

1. Chemistry is the study of …….
2. Much of the matter we encounter in everyday life is in the form of …….
3. ..……. are substances that cannot be broken down into simpler stuff by any chemical means.
4. Dimitri Mendeleev developed the ……. ……..
5. A pure substance made up of two or more elements in a fixed, characteristic composition and combination is a ..……..
6. The smallest unit of an element that can exist as a stable independent entity is an ……..
7. A chemical ……. is a symbolic representation of the elementary composition of chemical compounds.
8. A ..……. is a combination of a fixed number of atoms, held together in a certain geometric arrangement.
9. Isotopes are identified by their ..……. numbers – the sum of the number of protons and the number of neutrons in an atom.
10. Covalent bonds that are formed between two identical atoms are the strongest and are called ..……. covalent bonds because electrons are equally distributed between the two atoms. ..……. covalent bonds are formed between two different atoms.
11. ..……. bonds result when one or more valence electrons from one atom are completely transferred to a second atom.

2. Translate the following chemical groups (families) of the periodic table and assign the correct elements to each one.

Alkali metals:
Alkali earth metals:
Lanthanides (Rare earth elements):
Actinides (Rare earth elements):
Transition metals:

Poor (other) metals:
Metalloids:
Nonmetals:
Halogens (nonmetals):
Noble gases (nonmetals):

3. Find the differences between Czech and English terminology of the elements.

4. Translate the following names of the elements.

vodík	vápník	měď	hliník
olovo	kyslík	síra	draslík
křemík	uhlík	hořčík	železo
dusík	jod	zlato	stříbro

5. Read the names of the following symbols.

Mn, Fe, Os, Ba, Fr, Au, Ag, S, Se, Po, Rn, Yb, No, Es, Hg, Rh, Li, Na, K, Ar, Kr, Cl, O, N, As, Al, Pb, Ag, Cu, I

6. Translate the following information about one of the elements.

General information:

Name, Symbol, Number:	helium, He, 2
Chemical series (group, family):	noble gases
Group, Period:	18, 1
Appearance:	colourless
Atomic mass:	4.002602(2) g/mol
Electron configuration:	$1s^2$
Electrons per shell:	2

Physical properties:

Phase:	gas
Density:	(0°C, 101.325 kPa), 0.1786 g/L
Melting point:	(at 2.5 MPa) 0.95 K (272.2 °C, −458.0 °F)
Boiling point:	4.22 K (–268.93°C, −452.07°F)
Critical point:	5.19 K, 0.227 MPa
Heat of fusion:	0.0138 kJ/mol
Heat of vaporization:	0.0829 kJ/mol
Heat capacity:	(25 °C) 20.786 J/(mol . K)

Helium, chemická značka He, je plynný chemický prvek patřící mezi vzácné plyny a tvořící druhou nejvíce zastoupenou složku vesmírné hmoty.

Jedná se o bezbarvý plyn, bez chuti a zápachu, chemicky zcela inertní – nejsou známy žádné chemické sloučeniny helia. Helium má ze všech známých látek nejnižší bod varu a tání.

Helium při extrémně nízkých teplotách a normálním tlaku zůstává kapalné až k teplotě absolutní nuly. Je supratekuté.

Helium bylo vytvořeno nukleární syntézou ve hvězdách. Tvoří přibližně 25 % hmoty pozorovatelného vesmíru. Na Zemi, kde je hlavně produktem jaderného rozpadu prvků v zemské kůře, se ve větším množství nachází pouze v zemním plynu; jinak je jeho výskyt velmi vzácný.

Vzhledem ke své extrémně nízké hustotě a inertnímu chování se helium používá k plnění balónů a vzduchoplodí jako náhrada hořlavého vodíku, do dýchacích směsí určených pro potápění do velkých hloubek, jako ochranný plyn k mnoha průmyslovým účelům (např. svařování).

7. Water. Can you explain the following facts about water?

a) Water remains liquid at room temperature.
b) Water is the universal solvent.
c) Water is excellent transport medium in human and animal bodies.
d) The temperature of water in a liquid state is not liable to change drastically.
e) Water prevents our bodies from overheating.
f) Ice always floats on water.

8. Do we have enough water supplies? Fill in the correct word derived from the word in bold.

Probably everybody knows that water is indispensable for life on the planet. Many people take water for 1. **GRANT**. However, there is a growing need to change such attitudes. As a result of the extremely large populations currently 2. **LIFE** on our planet a lot of countries are experiencing 3. **SHORT** of water supplies. They have already learnt the fact that water is a 4. **PRECIOUSNESS** thing which ought to be 5. **PROTECTION**. One way how to get more drinking water 6. **SUIT** for animal and human consumption is to use "desalination". It refers to a process by which 7. **EXCESS** amounts of salt and other minerals are removed. Therefore, salt water is converted to 8. **DRINK** fresh water. China, which suffers greatly from inadequate 9. **SUPPLIER** of water, has been using desalination since 1958.

In Europe there is still enough water, however, its quality is decreasing. Will we also experience a lack of water supplies in the near future?

9. Nuclear power.

a) Read the following article.

b) Can you add any other facts concerning nuclear power?

Nuclear power is a technology which applies nuclear reactions, especially nuclear fission, in order to release energy for useful purposes including propulsion, heat, and the generation of electricity. It uses a dangerous element called uranium. It is a metal extracted from rocks, soil, and oceans in various parts of the world.

Sometimes the era we live in is called the *Nuclear Age*. Its commencement dates back to 1945 when the USA tested nuclear weapons. 'The first nuclear power station was opened in England in 1956. The nuclear power accounts for approximately 6.5% of the world's energy and 16% of the world's electricity. The IAEA (International Atomic Energy Agency) reported the existence of 439 active nuclear power reactors in 31 countries. In Europe the biggest number of the nuclear power stations was built in France, on the other hand some countries, such as Austria and Ireland, do not have any in operation.' [wikipedia.org/wiki/Nuclear_power]

Worldwide there has been growing a big political resistance towards the nuclear power. In many countries the research in this field has stopped and the nuclear power stations have been shut down. Nevertheless, many countries remain active in research and development of the nuclear power and weapons.

c) Are you in favour of or against nuclear energy. Prepare a small speech justifying your opinion.
Proponents of nuclear energy claim that:

- It produces huge amounts of energy.
- It does not pollute the air compared to burning fossil fuels.
- The risks of storing nuclear waste are very small.
- The operation of the nuclear power plants is safe.
- In future there will be a shortage of electricity unless we continue to use the nuclear power.
- Heavy metal emissions from fossil fuels contribute to global warming.
- Fossil fuels' prices are rising.
- .....

Critics of nuclear energy think that:

- It is uneconomic and potentially dangerous energy.
- We cannot be sure whether the costs and risks can be reduced using some new technologies.
- There is a danger of possible radioactive contamination due to some accident. People have not forgotten Černobyl!
- A potential danger of nuclear proliferation is too high.
- It is a risk to the environment and to humanity which must not be taken.
- To store nuclear waste is too risky.
- Building a sufficient number of nuclear power stations to significantly reduce the greenhouse gas emissions would cost billions of dollars. It would produce massive amounts of high-level radioactive waste.
- The nuclear power stations are excellent targets for terrorist attacks.
- The USA, Russia, France, the UK and China (and maybe some other countries) posses dangerous nuclear weapons. Anyway, any country that owns a nuclear power station is a potential nuclear weapon producer.
- .....

10. Greatest inventions.

a) Discuss:

1. How does science affect our everyday lives?
2. What can scientists do to make science more understandable to public?
3. Do you think it is a good idea to popularize science?

b) Think of the greatest inventions that changed our lives throughout the history. Write as many as you can.

……
……
……

c) Descriptive language.
Describe the use of some of the inventions that you have come up with.
Use the words like: *machine, equipment, tool, instrument, thing, device and so on.*
Say what it is used for.
Do not forget to describe its *shape, size, material, and purpose*.

Example: *A **television** is a device which has a rectangular or square shape and a screen in front. It receives electrical signals and turns them into moving images and sound over a distance. It is quite common to have one or two TV sets in every household. It is used for entertainment and education.*

d) Game. Saving the greatest inventions.

Imagine that the world is going to collapse. There is a way how to save some of the greatest inventions and take them to another planet which has been discovered in an attempt to save the mankind and some of the best things that have ever been created. A special space shuttle has been invented in order to carry the inventions. Regrettably, only a few healthy man and women have been honoured to travel in the shuttle. They are to start a new generation and preserve the greatest inventions. However, there is one big problem troubling them right now. Because of limited space in the shuttle there is no way that all the inventions can fit in.

Work in pairs and choose one invention that you like. Your task is to discuss all the advantages that in your opinion could contribute to the new life on another planet. Prepare your arguments carefully because you ought to persuade your schoolmates that your invention is the best. Your motivation is that you can "survive" together with your invention. At the end everybody will have to decide who shall be taken and who shall be left behind.

11. Check your grammar. Active and passive.

Rewrite the following sentences, replacing the active form in italics by the passive form.

Examples: *Fibre **is removed** in the production of white flour.*
*Further studies of this problem **are being carried out**.*
*Many similar claims **have been made**.*
*A new drug **was developed**.*

1. A group of Japanese surgeons *are performing* the operation.
2. Watson and Crick *had proposed* the double-helix model of DNA before Pauling *described* the alpha-helix of giant protein molecules.
3. They *discovered* the layout of bases, sugars, and phosphates within the molecule during the 1930s and 1940s.
4. You *can split* the atom into smaller particles such as protons, electrons, and neutrons.
5. You *may ascertain* the presence of obesity from an examination of the patient, but you *need* a weighing machine or scales to measure their weight accurately.
6. The surgeon *x-rayed* my lungs yesterday and I wonder why he *has x-rayed* my lungs today again.

UNIT 3

CHEMICAL LABORATORY

A laboratory (often abbreviated as "lab") is a place where scientific research and experiments are conducted. A laboratory can hold space for one to thirty or more researchers, depending on the size of the room and state-mandated maximum occupancy limit.

All laboratories share some common features, mainly laboratory equipment and laboratory glassware. Usually, they have at least one **fume hood**, where toxic and hazardous chemicals can be safely handled. This reduces, and usually eliminates, the risk of inhalation of toxic gases produced by the reaction of chemicals. Laboratories usually have a **sink** for handwashing. A **fire extinguisher** is located in a laboratory, as well as a **fire blanket**, to help exterminate fire in the event of an accident. There is also an **eye wash station** and an **overhead shower** in the event that chemicals come into contact with your clothes, skin, or eyes.

Supporting the laboratory is usually a **stockroom**, or **preparation room**, where dry and wet chemicals are stored. This stockroom prepares all the reagents (acids and bases) of various quantities and concentrations. It also orders and distributes supplies (glassware, chemicals, and personal protective equipment) to the laboratory.

When researchers perform experiments in the laboratory they use pure phases and sterile reagents. Impure chemicals undergo purification first and then are used in an experiment; non-sterile reagents are first autoclaved before use. Impure and non-sterile reagents interfere with experiments causing undesired results.

The equipment and orientation of a laboratory will ultimately depend on its purpose. University laboratories, as well as chemical and biochemical laboratories, will contain myriad of glassware. In these laboratories, general experiments will be performed to isolate or purify compounds, or perform research to gain new knowledge on a given compound or scientific idea.

Other common laboratory equipment includes: **centrifuges** to remove solid particles from a liquid, or create a density gradient; **spectrophotometers** to accurately measure the optical absorbance of a liquid and particular wavelength (measure its colour); **aspirators** for providing suction; and **water baths** that maintain a substance at a particular temperature.

While there is a typical set of **glassware** used for conducting various experiments, other laboratories have different requirements and arrangements.

Microbiology laboratories usually have separate rooms with negative pressure to prevent the breathing in of harmful bacteria. Air is often passed through a number of filters and then re-pumped into the room.

Laboratories designed for processing specimens, such as environmental research or medical laboratories, will have specialised **machinery** (automated analysers) designed to process many samples and numerous tests. Research and experimentation is not a priority in these laboratories; the aim is to give a fast and reliable result.

Exercises

1. General laboratory safety rules.

Fill the following words into the blanks.

containers	**forbidden**	**hygiene**	**smoking**	**permitted**	**illegible**
glasses	**glassware**	**spills**	**equipment**	**suction**	**protective**
washing	**smell**	**procedures**	**store**	**horseplay**	**contact**

1. Know all emergency …… and how to use emergency ……
2. Use personal …… equipment as required.
3. Eating, drinking and …… in the labs is strictly forbidden.
4. Label all …… you fill and replace missing or …… labels.
5. …… is strictly forbidden.
6. Safety …… are mandatory in all lab areas.
7. Do not use your mouth …… to pipette chemicals or start a siphon: a pipette bulb or aspirator should be used to provide vacuum.
8. Use good personal ……. and wash hands before leaving a lab.
9. Use of solvents for …… the skin is forbidden.
10. If skin …… with any chemical occurs, wash immediately.
11. Chemicals are …… in eating areas.
12. Never use lab …… to prepare food.
13. It is forbidden to …… and/or prepare food in the same equipment used for laboratory operations (e.g. refrigerators and microwaves).
14. …… must be cleaned up immediately and disposed of properly.
15. Contact lenses are not …… to be worn in laboratories.
16. Never …… or taste a chemical to identify it.

2. Safety phrases.

Under EC legislation, data sheets available in the UK now contain codes for certain "safety phrases". These phrases are also extensively used elsewhere in the world. Safety phrase codes have the following meanings.
Fill in the missing verbs listed below.

breathe	**induce**	**keep**	**handle**	**seek**
wear	**keep in**	**empty**	**avoid**	**take off**
keep away from	**rinse**	**disposed of**	**keep out of**	**smoke**

1. …… the reach of children.
2. …… a cool place.
3. …… container tightly closed, dry, and in a well-ventilated place.
4. …… food, drink, and animal foodstuffs.
5. …… and open container with care.
6. When using, do not eat, drink or……
7. Do not …… dust or vapour.
8. …… contact with skin and eyes.
9. In case of contact with eyes, …… immediately with plenty of water and

10. …… medical advice.
11. …… immediately all contaminated clothing.
12. Do not …… into drains.
13. This material and its container must be …… in a safe way.
14. …… suitable protective clothing, suitable gloves, and eye/face protection.
15. If swallowed, do not …… vomiting; seek medical advice immediately and show this container or label.

3. Here is a list of some verbs used when working in a chemical laboratory. Translate them and separate them into the columns according to their endings.

zředit	**odpařovat**	**srážet**	**zkapalnit**	**rozkládat se**
zahrnovat	**oddělit**	**okyselit**	**usadit**	**třepat**
způsobit	**filtrovat**	**ztuhnout**	**měřit**	**čistit**
vylouhovat				

– fy	– tate	– rate	– e
……..…	……..…	……..…	……..…
……..…	……..…	……..…	……..…
……..…		……..…	……..…
……..…			……..…
			……..…
			……..…
			……..…

4. Laboratory equipment.
Match the words in the two boxes and translate the expressions into Czech.

switch, Bunsen, undesirable, gas, laboratory, boiling, roaring, harmful, analytical, laboratory, refractory, glass, evaporating, graduated

….

flame, balance, vessel, dropper, vapours, button, dish, burner, assistant, jet, odours, glass, glassware, flask

5. Assign each expression from the box to its definition.

condenser	**laboratory apron**	**graduated dropper**	**burner**
pipette	**refractory glass**	**crucible**	**gown**
furnace	**stopper**	**test tube**	**burette**
stand-up bench	**filter-paper**	**test tube rack**	**funnel**

1. A piece of clothing worn as a protection for the front of the body.
2. A conic, hollow structure with a narrow opening at the apex, such as the vessels used in chemistry and pharmacy for filtering and other purposes.
3. A container, usually cylindrical, made from glass that is resistant to heat.

4. A porous material made from wood that is used as a device for the straining of water or other liquids.
5. A graduated glass tube used in volumetric chemistry to deliver a measured amount of liquid.
6. A vessel or apparatus for condensing gasses or vapours.
7. A tube of thin glass closed at one end, used for various procedures in chemistry and for observing the growth of bacterial cultures.
8. A pipette or tube for dispensing liquid in drops.
9. A desk you work at in a chemical laboratory.
10. A loose flowing robe worn especially by a professional or academic person when acting in an official capacity.
11. Something, a bung or cork, used to plug an opening.
12. A vessel for melting refractory substances.
13. A framework or a stand holding a tube of thin glass.
14. The part of a lamp, stove, or furnace from which the flame issues.
15. An enclosed apparatus in which heat is produced.
16. A glass or transparent plastic tube used in measuring or transferring small quantities of liquid or gas.

6. Check your grammar.
Do you remember?

Time clause: use **when, while, before, after, until,** and **as soon as** combined with a present tense (present simple or present perfect)
Main clause: use **will, going to, imperative,** and **modals**

Example: *I'll come **as soon as I finish**.*
***When I go** shopping, I'll buy some food.*
*You'll feel better **after** you**'ve had something to eat**.*

1. I …….. (phone) you as soon as I …… (get) home from work.
2. I want to see Margaret before she …….. (go) out.
3. We're going on holiday tomorrow. I …….. (tell) you about it when we ……. (come) back.
4. Brian looks very different now. When you …… (see) him again, you …… (not/recognize) him.
5. We must do something soon before it …… (be) too late.
6. I don't want to go without you. I …….. (wait) until you …….. (be) ready.
7. He made me very angry. I won't talk to him until he …… (apologize).
8. Let's go home before it …… (get dark).

7. Translate.

1. Laboratorní stojan by měl být nehořlavý, z chemicky odolného materiálu (nereaktivní a neměl by se kývat). Mělo by být snadné na něj uchycovat předměty.
2. Byreta se používá při titraci. Jejím kohoutem z ní vypouštíme roztok určité chemické látky (tzv. činidla) do titrační baňky s roztokem jiné látky. V titrační baňce pak proběhne požadovaná chemická reakce. Pomocí stupnice na byretě dokážeme určit přesný objem použitého činidla.
3. Vysoká teplota při žíhání by skleněnou kádinku velmi pravděpodobně zničila. Látky proto žíháme v kelímcích z těžkotavitelných materiálů – vhodný je porcelán nebo platina.
4. Erlenmeyerova baňka se používá např. k uchovávání roztoků, které máme v úmyslu chladit tekoucí vodou a pak vylít jinam. Úzké hrdlo E. baňky zmenšuje nebezpečí vniknutí vody do roztoku uvnitř baňky a umožňuje baňku snadno uzavřít.

5. V titrační baňce probíhá chemická reakce při titraci. Umístíme do ní titrovaný roztok a pak za stálého míchání přidáváme tzv. činidlo z byrety. Výhodou titrační baňky je kulovitý tvar spodní části, který umožňuje dobré promíchávání titrovaného roztoku, a dlouhé válcovité dostatečně široké hrdlo, které brání vyšplíchnutí obsahu baňky ven, ale umožní snadné přidávání roztoku z byrety.
6. Síťka s keramickou výplní se dává pod zahřívané kádinky nebo baňky, aby nepraskaly.
7. Pipeta se používá k přesnému odměření objemu roztoku. Pipetovaný roztok do pipety nasajeme (většinou ústy nebo pomocí vhodného mechanického zařízení) tak, aby jeho hladina sahala přesně po tzv. rysku (značku na pipetě), a pak jej z pipety vypustíme do určené nádoby.
8. Trojnožka se používá při zahřívání předmětů kahanem. Pod trojnožku postavíme kahan, na trojnožku položíme síťku s keramickou vložkou a na ni zahřívaný předmět.
9. Rtuťový teploměr obsahuje rtuť, jejíž páry jsou jedovaté. Proto se musíme snažit předejít jeho rozbití.
10. Laboratorní kleště je nutno nahřát v plameni dříve, než jimi uchopíme horký křehký předmět. Pokud to neuděláme, předmět při tepelném šoku praskne.

8. Let's laugh a little!

a) Last words of a chemist.

- And now the tasting test...
- And now shake it a bit...
- Which glass was my mineral water in?
- Why does that stuff burn with a green flame?!?
- And now the detonating gas problem.
- This is a completely safe experimental setup.
- Now you can take the protection window away...
- Where do all those holes in my kettle come from?
- And now a cigarette...

b) A poem.

Little Johnny took a drink,
Now he shall drink no more.
For what he thought was H_2O,
Was H_2SO_4.

UNIT 4

PLANT BODY, CELL, PHYSIOLOGY

4.1 Plant Cell

The cells of plants are quite different from the cells of most other organisms. Their distinctive features are:

A **large vacuole** (enclosed by a membrane, the tonoplast), which maintains cell turgor (osmotic pressure).

A **cell wall** made up of cellulose and protein, and in many cases lignin. It is deposited on the outside of the cell membrane. A cell wall provides structural and mechanical support to the cell and maintains its shape.

Plastids, especially **chloroplasts** that contain **chlorophyll**, the pigment that gives plants their green color.

4.2 Animal Cell[1]

Animal cell is a form of eukaryotic cell which make up many tissues in animals. The animal cells are distinct from other eukaryotes, most notably plant cells, because they lack cell walls, chloroplasts and large vacuoles. Due to the lack of a rigid cell wall[1], animal cells appear to be circular (though are often deformed by surrounding cells) under microscopes.

4.3 Common structures

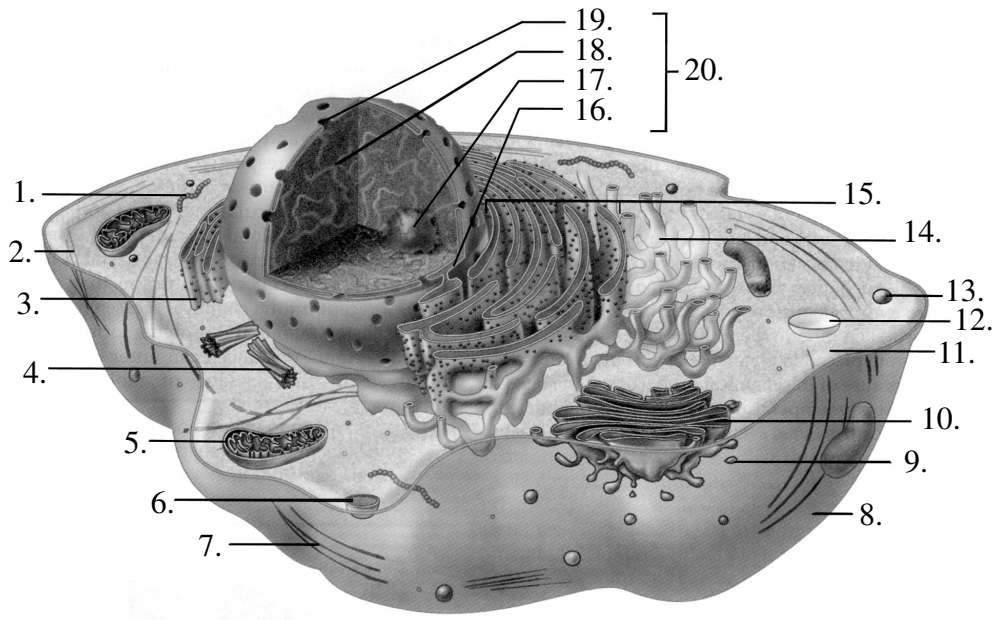

Figure 4.1 Animal cell.

[1] Animal cells have an outside cell membrane only.

Plant and animal cells share many similar structures, such as a nucleus, a cell membrane, a cytoplasm, and many organelles.

A **nucleus** contains most of the cell's DNA, and mitochondria, the 'power plants' of the cell (their primary function is to convert organic material into energy in the form of ATP).

A **cell membrane** is a thin layer of protein and fat surrounding cells that keeps the cells together and controls substances passing between the cytoplasm and the inter-cellular space. The cell membrane is semi-permeable, allowing certain substances to pass through. Substances often cross the membrane by diffusion, a spontaneous passage of molecules. Water movement across the membrane is a special case of diffusion known as osmosis.

A **cytoplasm** is a homogeneous, generally clear jelly-like material that fills cells (the part of cells outside the nucleus and outside the large vacuole of plant cells). Cytoplasm consists mainly of water, electrolytes, carbohydrates, proteins, and lipids. Organelles are embedded in the cytoplasm. These include ribosomes, endoplasmic reticulum, Golgi apparatus, mitochondria, lysosomes, centrioles, and the cytoskeleton. The cytoplasm plays a mechanical role, it maintains the shape and the consistency of the cell. It is also a storage place for chemical substances indispensable to life. Vital metabolic reactions take place here, e.g. protein synthesis, and waste products are released from the cell.

4.4 Plant Body

4.4.1 Root System

A root is a plant structure that absorbs water and inorganic nutrients, stores energy, and anchors the plant body to the ground. Most roots grow underground but they can also be *aerial* (i.e. growing above the ground) or *aerating* (i.e. growing up above the ground or especially above water).

At the tip of every growing root is a conical covering of tissue called the **root cap**. The root cap provides mechanical protection to the meristem (continuously dividing) cells as the root advances through the soil.

The outside surface of a root is the **epidermis**. Recently produced epidermal cells absorb water from the surrounding environment. The process is known as **osmosis**.

Roots will generally grow in any direction where the correct environment of air, nutrients, and water exists to meet the plant's needs.

Tap root is the main root of some plants; the tap root extends straight down under the plant; from the tap root grow **lateral roots**.

4.4.2 Shoot System

A **stem** is the above ground axis of a vascular plant. Its basic functions are structural support of the plant, growth through increase in diameter, and elongation and transport of fluids between the roots and the leaves.

A **shoot** is the fresh young growth of a plant stem. **Lateral shoot (branch)** is an offshoot of the stem of a plant.

A **node** is the part of the stem from which a leaf, branch, or aerial root grows. The parts of the stem between nodes are referred to as **internodes**.

A **bud** is an undeveloped shoot and normally occurs in the axil of a leaf or at the tip of the stem. Once formed, a bud may remain for some time in a dormant condition, or it may form a shoot immediately.

A **terminal bud** is a bud located at the apex (tip) of the stem. Terminal buds have special tissue, called apical meristem, consisting of cells that can divide indefinitely.

A **leaf** is an above-ground plant organ specialized for **photosynthesis**. For this purpose, a leaf is typically flat and thin, to expose the chloroplast containing cells (***chlorenchyma*** tissue) to light over a broad area, and to allow light to penetrate fully into the tissues. Leaves are also the sites in most plants where respiration, transpiration, and guttation take place. Leaves can also store food and water.

A **petiole** is a leaf stalk. It attaches the leaf to the plant (the larger part of the leaf is called a **blade**).

An **axil** is the angle between the upper side of the stem and a leaf, branch, or petiole. An **axillary bud** is a bud that develops in the axil.

4.5 Flower Anatomy

A flower is the reproductive organ of the plants classified as **angiosperms** (flowering plants). The function of a flower is to produce seeds through sexual reproduction. For the higher plants, seeds are the next generation, and serve as the primary means by which individuals of a species are dispersed across the landscape. After fertilization, a flower develops into a fruit containing the seed(s).

A flower is a modified stem with shortened internodes and bearing structures that may be highly modified leaves. The stem is called a **pedicel.** The parts of a flower are arranged in whorls.

Petals are usually thin, soft, and colored to attract insects that help the process of pollination. The whorl of petal forms a **corolla**.

Sepals are typically green leaves around the outside of the flower. They are usually smaller than the petals. They protect the flower while it is still in bud. The whorl of sepals forms a **calyx**.

Stamens are a male part of the flower. Consist of the **filament** (a thin stalk) and the **anther** (a swelling at the top of the stalk). **Pollen**, which contains the male gamete, is formed on the **anther**.

Carpel (**Pistil**) is a female part of the flower. It contains the **ovary**, **stigma**, and **style**. The sticky tip of tip of the pistil, the stigma, is the receptor of pollen. The supportive stalk, the style, becomes the pathway for pollen tubes to grow – from pollen grains adhering to the stigma, to the **ovules** – carrying the reproductive material. The ovules, which contain the female gamete, are found in the ovary.

In the majority of species, individual flowers have both pistils and stamens as described above. These flowers are referred to as being **perfect**, **bisexual**, or **hermaphroditic**. However, in some species of plants the flowers are **imperfect** or **unisexual**: having only either male or female parts.

Some flowers with both stamens and a pistil are capable of **self-fertilization**, which does increase the chance of producing seeds but limits genetic variation. Conversely, many species of plants have ways of preventing self-fertilization. Those are referred to as **self-sterile** or **self-incompatible**.

4.6 Plant Physiology

Plant physiology is the study of the function of plants. Fundamental processes such as **photosynthesis**, **respiration** and **transpiration** are studied by plant physiologists.

Plants are **autotrophs**[2]; it means that they are able to synthesize food directly from inorganic compounds, instead of eating other organisms or relying on material derived from them. Plants obtain their energy from photosynthesis.

4.6.1 Photosynthesis

Photosynthesis (from the Greek *phos* = light and *synthesis* = combination) is a biochemical process by which the energy of light is converted into chemical energy in plants, algae, and certain bacteria. It is responsible for producing the oxygen that makes up a large portion of the Earth's atmosphere. Organisms that produce energy through photosynthesis are called **phototrophs**. Plants capture light using

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[2] An **autotroph** (from the Greek ***autos*** = self and ***trophe*** = nutrition) is an organism that produces organic compounds from carbon dioxide as a carbon source, using either light or reactions of inorganic chemical compounds, as a source of energy.
A **heterotroph** (Greek *heteron* = (an) other and *trophe* = nutrition) is an organism that requires organic substrates to get its carbon for growth and development. All animals are heterotrophic, as well as fungi and many bacteria. Some parasitic plants have also turned fully or partially heterotrophic.
Heterotrophs are unable to synthesize organic, carbon based compounds from the inorganic environment's sources; they must obtain their carbon from organic compounds. In simpler terms, a heterotroph is an organism that is incapable of making its own food from light or inorganic compounds, and feeds on organisms or the remains of other organisms to get its necessary energy to survive.

the pigment chlorophyll, which gives them their green color. This is contained in organelles called chloroplasts. Although all green parts of a plant have chloroplasts, most of the energy is produced in the leaves that are the primary site of photosynthesis in plants. Photosynthesis is carried out in two steps, first in two light-dependent photosytems and then in a carbon fixation cycle (Calvin Cycle). Through this process, the plant is able to convert sunlight, water, and CO_2 into glucose and ATP. As a byproduct of this process, O_2 is released. The plant's ability to convert water and CO_2 into glucose and O_2 also provides great benefit for animal species that depend on glucose for energy. The photosynthetic reaction can be summarized as follows:

$$6\ CO_2 + 12\ H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + 6\ H_2O + 6\ O_2$$

4.6.2 Transpiration

Transpiration is a continuous process caused by the evaporation of water from leaves of plants and its corresponding uptake from roots in the soil. Transpiration cools plants down and enables mass flow of minerals to where it is needed in the plant. Water is absorbed at the roots by osmosis, and any dissolved solutes travel with it through the **xylem**[3].

4.6.3 Tropism

Tropism is a biological phenomenon, indicating growth or turning movement of a biological organism, usually a plant, in response to an environmental stimulus. The word tropism comes from the Greek *tropos* ("to turn"). Tropisms may be either **positive** (towards the stimulus) or **negative** (away from the stimulus). Tropisms are usually named for the stimulus involved (for example, a ***phototropism*** – reaction to light, ***gravitropism*** or ***geotropism*** – turning or growth in response to gravity, ***chemotropism*** – movement caused by a chemical stimulus, ***hydrotropism*** – movement or growth in response to moisture).

4.6.4 Reproduction

Plants use a variety of means to reproduce, both **sexually** and **asexually**.

- **Asexual (vegetative) reproduction**

It is cloning. A piece of a plant may root or sprout and grow into a new plant which is genetically identical with the parent. It involves the **growth** of parts which eventually become detached to form new plants (for example bulbs, corms, tubers, and rhizomes are all parts of certain plants which can grow into new plants). It is both a natural process in many plant species (including organisms that may or may not be considered "plants", such as bacteria and fungi[4]) and one utilized or encouraged by horticulturists to obtain quantities of economically valuable plants. Asexual reproduction involves only one parent without the formation of gametes, this means that offspring is produced with the same genetic composition as the parent. Consequently, asexual reproduction does not introduce variation.

- **Sexual reproduction of plants**[5]

It employs many different strategies. In essence it is any process by which new plant "individuals" arise through the production of seeds or spores. Sexual reproduction involves two parents, one male and one female. The parents' sex cells divide by meiosis producing gametes. The fusion of a male and female gamete produces a **zygote**, from which a new individual develops. Sexual reproduction results in a new plant which contains genetic material from two parents, but which is not genetically identical with either one. The new organism will differ from both parents, and variation is introduced.

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[3] In vascular plants, **xylem** is one of the two types of transport tissue in plants, **phloem** being the other one. The xylem transports sap from the root up the plant: xylem sap consists mainly of water and inorganic ions, although it can contain a number of organic chemicals as well.

[4] For example, some one-celled algae undergo a process called **fission**. This means it duplicates its genes and splits apart.

[5] In **flowering plants**, a stamen produces male gametes called pollen grains, which attach to a pistil, in which the female gametes (ovules) are located. Here, the female gamete is fertilized and develops into a seed. The ovary, which produced the gamete, then grows into a fruit, which surrounds the seed(s). Plants must be pollinated. Plants may either self-pollinate or cross-pollinate.