

# I. Biology

## Part 1 – Cell Biology

- Types and function of lipids
- Biologically important carbohydrates
- Primary, secondary, tertiary and quaternary protein structure
- The structure of DNA and RNA
- Types and function of RNA molecules
- What are the enzymes and how are enzymes regulated?
- Glycolysis
- The citric acid cycle
- Mechanism of ATP production in the mitochondria
- Replication
- Transcription
- Translation
- The nucleus
- Chromosomes
- Endoplasmic reticulum
- The Golgi apparatus
- Ribosomes
- Cytoskeleton
- Exocytosis, endocytosis
- The cell membrane
- Mitosis
- Meiosis
- Structure of the bacterial cells
- Transformation, conjugation and transduction
- Structure of the viruses

## Part 2 – Physiology

- Parts of the digestive system
- Digestive enzymes, absorption of food and water
- Parts of the respiratory system, mechanism of inhalation and exhalation
- Oxygen and carbon dioxide exchange in the lungs
- Parts of the excretory system
- Water and ion transport in the kidneys
- Parts of the circulatory system
- Structure and function of the heart
- Blood, composition, cell types
- The cellular immune response
- The humoral immune response
- Muscles, bones, joints
- Muscle contraction

- Parts of the male reproductive system
- Parts of the female reproductive system
- The ovarian cycle and the uterine cycle
- Hormonal control of the reproductive system
- The pituitary gland and its hormones
- The adrenal gland and its hormones
- The thyroid gland and its hormones
- The pancreas and its hormones
- The autonomic nervous system
- The spinal cord, spinal reflexes
- Parts of the human brain, function of the brain lobes
- Nerve cell structure, resting and action potential
- Neurotransmitters and synaptic transmission
- The structure of the human eye
- Mechanism of vision
- The structure of the human auditory system and the mechanism of hearing
- The olfactory system

### **Part 3 – Genetics**

- The Laws of Mendel
- Structure of the genes
- Levels of gene expression
- Mutations: types and consequences
- Human chromosome number aberrations, genetic diseases
- Dominant-recessive inheritance
- Sex-linked inheritance
- The genetic code
- The lactose operon

### **Part 4 – Evolution**

- Darwin's theory
- Origin of life

### **Recommended reading:**

Life, The science of biology (last edition)

## II. Chemistry

### Part 1 – General and Inorganic Chemistry

- Elements and compounds. The mole concept, Avogadro's number
- Basic structure of atoms and the quantum numbers
- Periodic table. Periodic properties
- Types of chemical bonding
- Lewis structure. Geometry of molecules
- Intermolecular forces. Types of solids
- Chemical equilibrium. LeChatelier's principle. Examples for chemical equilibrium
- Acid-base theories
- Definition of pH, the pH scale. Examples for strong and weak acids and bases
- Solutions. Ways of expressing composition of solutions
- Definition of oxidation and reduction. Examples for redox reactions.
- Carbon and its inorganic compounds
- Nitrogen and its compounds
- Phosphorous and its compounds
- Sulfur and its compounds

### Part 2 – Organic Chemistry

- Functional groups. Types of organic chemical reactions
- Isomerism in organic compounds. Types and examples
- Alkanes. Nomenclature, physical and chemical properties
- Alkenes and alkynes. Nomenclature, physical and chemical properties
- Aromatic hydrocarbons: examples, chemical reactions
- Alcohols: classification, preparation, physical properties
- Alcohols: chemical properties and most important representatives
- Ethers and phenols
- Oxo compounds: classification and oxidation-reduction reactions
- Carboxylic acids. Nomenclature, physical and chemical properties
- Carboxylic acid derivatives: esters and amides
- Amines: classification, nomenclature, examples for their chemical reactions
- Proteinogenic amino acids: examples. The peptide bond
- Carbohydrates: definition, classification, most important representatives
- Components of nucleic acids

### III. Physics (alternatively selectable for University of Szeged)

- Speed and velocity. Acceleration. Uniform motion and linear motion with constant acceleration
- Newton's laws. Force and the principle of superposition
- Types of forces. Forces of friction; Hooke's law
- Mass and weight. Universal law of gravitation
- Work and kinetic energy. Work-energy theorem
- Potential energy. Law of conservation of energy
- Linear momentum. Elastic and inelastic collisions
- Circular motion. Centripetal acceleration and centripetal force
- Simple harmonic motion
- Mechanical waves. Interference, diffraction and standing waves. Sound, Doppler effect
- Elasticity. Stress and strain, Hooke's law. Types of stress
- Torque and lever arm. Conditions of equilibrium
- Pressure in fluids: Pascal's principle, pressure-depth relation. The hydraulic press
- Archimedes' principle, buoyancy
- Concept of temperature, temperature scales. Thermal expansion
- Heat capacity and specific heat. Change of phase and latent heat
- The ideal gas law. Isothermic, isobaric, isochoric processes
- Kinetic theory of gases. The first law of thermodynamics
- Light as an electromagnetic wave. Reflection and refraction. Dispersion and colors of light
- Optical instruments: mirrors and lenses
- Electric charges and Coulomb's law. Electric field, electric field lines
- Electric flux, Gauss's law. Electrical potential, equipotential surfaces. Capacitors
- Electrical current, resistance, Ohm's law
- Kirchhoff's rules
- Magnetic field, magnetic force. The force on acting on a current-carrying wire in a magnetic field
- Magnetic induction: Faraday's law, Lenz's law

#### Recommended reading:

Holzner, Steven. *Physics essentials for dummies*. Hoboken: Wiley, 2010

Serway R A, Jewett J W. *Physics for scientists and engineers*. Thomson Brooks/Cole, 2004

Arfken G B, Griffing D F, Kelly D C and Priest J. *University Physics*. Orlando: Academic Press, 1984

Tipler, Paul A. *College Physics*. New York: Worth Publishers, 1987