PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

Higher School of Saharan Agriculture

El Oued

Academic Program

1st Cycle (Preparatory Class)

1st Year

1st Semester

Semester: 01
Teaching Unit: Fundamental
Subject: CELL BIOLOGY
VHS: h (C /T/TP)
Credits: 8
Coefficient: 4
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

This unit describes the structure of the living cell, its functioning, and the interactions between its different compartments. It is based on fundamental concepts such as the relationship between molecular structure and function, the dynamic nature of cellular organelles, the use of energy in cellular activities, the biosynthesis of macromolecules, and the regulatory mechanisms of cellular activities.

Course content:

Chapter 1: Introduction to the Living World

- Classification of living organisms
    - Prokaryotes
    - Eukaryotes
    - Viruses
- Unicellular and multicellular organisms
- Levels of cellular organization

Chapter 2: Cell Structure

- Prokaryotic cell
    - General organization
- Eukaryotic cell

  Ultrastructure and organelles:
    - Nucleus

- Plasma membrane
- Cytoplasm
- Endoplasmic reticulum
- Golgi apparatus
- Mitochondria
- Lysosomes
- Peroxisomes
- Centrosome
- Cytoskeleton
- Animal cell
- Plant cell: cell wall, vacuole, plastids

Chapter 3: The Plasma Membrane

- Structure and composition: Lipids, proteins, membrane carbohydrates
- Structural organization
- Physiological functions:
    - Permeability
    - Passive and active transport
    - Vesicular transport: endocytosis, exocytosis
- Membrane specializations

Chapter 4: The Endomembrane System

- Endoplasmic reticulum
- Golgi apparatus
- Role in intracellular dynamics

Chapter 5: The Nucleus and the Cell Cycle

- Structure and functions of the nucleus

- Phases of the cell cycle
- Mitosis and meiosis

Chapter 6: Cytoskeleton and Extracellular Matrix

- Cytoskeleton: microtubules, microfilaments, cytokeratin
- Extracellular matrix: components and role

Chapter 7: Specialized Cellular Functions

Neurotransmission

- Structure of the neuron
- Membrane potential
    - Resting potential
    - Action potential (A.P.)
- Neuron excitability
    - Threshold of excitation o
      All-or-none law
- Neuron conductivity
    - Mechanism of action potential propagation
    - Conduction velocity of nerve impulse
    - Direction of nerve impulse propagation

Muscle Contraction

- Muscle fiber
- Sarcomere
- Contraction mechanism
- Calcium pump

Directed Work (Tutorials)

- **TD 1:** Cell structure (interphase nucleus, cytosol, Golgi apparatus, endoplasmic reticulum, lysosomes, endosomes)
- **TD 2:** The cell cycle
- **TD 3:** Neurotransmission (membrane potential, neuron excitability, neuron conductivity, synapse, etc.)
- **TD 4:** Muscle contraction (types of contraction and biochemical changes)

Practical Work

- **TP 1:** Methods and techniques for studying the cell
- **TP 2:** Microscopic study of plant and animal cells
- **TP 3:** Plasma membrane and cellular exchanges (osmosis, diffusion, etc.)
- **TP 4:** Ultrastructure of the cell and its organelles

Semester: 01
Teaching Unit: Fundamental
Subject: Geology
VHS: h (C/TP)
Credits: 4
Coefficient: 2
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

This course aims to provide students with a solid understanding of the structure, composition, and dynamic processes of the Earth within the universe. It enables students to master the fundamental concepts of plate tectonics, including geodynamic processes such as subduction, collision, and oceanic expansion. Students will develop the ability to identify and classify minerals and rocks (igneous, sedimentary, and metamorphic) based on their physical and chemical properties. The course also introduces key principles of stratigraphy and geological time, including relative dating and radiometric methods.

Course Content

1. The Earth in the Universe

A. Structure of the Earth

1. Surface layers
2. The solid Earth (geosphere)
3. Geothermal gradient
4. Distribution of densities and propagation of seismic waves
5. Chemical composition of the different layers of the solid Earth:
   a. The crust (continental and oceanic)
   b. The mantle
   c. The core

B. Plate Tectonics

1. Continental drift
2. Definition of tectonic plates
3. Geodynamic settings related to convergent plate boundaries:
   a. Subduction zones
   b. Collision zones
   c. Island arc zones
4. Geodynamic settings related to divergent boundaries:
   a. Mid-ocean ridges and ocean expansion
   b. Continental rifts
5. Earthquakes
6. Morphology of continents
7. Morphology of ocean floors
8. Theory of isostasy

C. Elements of Tectonics

a) Concepts of stress and deformation
b) Markers of deformation (faults, folds, tension cracks, etc.)
c) Extensional deformation regime
d) Compressional deformation regime

D. Crystallography and Mineralogy

1. Crystalline state and crystal systems
2. Chemical bonds and coordination polyhedra
3. Silicates
4. Non-silicates
5. Physical properties of minerals

E. Igneous Rocks

1. Definition
2. Types of magma

3. Processes of formation of igneous rocks:
    a. Partial melting
    b. Fractional crystallization
4. Classification criteria and nomenclature of igneous rocks

F. Sedimentary Rocks

1. Origin of sediments
2. Processes of formation of sedimentary rocks:
    a. Weathering (physical and chemical)
    b. Transport
    c. Sedimentation
    d. Diagenesis
3. Classification criteria and nomenclature of sedimentary rocks

G. Metamorphic Rocks

1. Definition
2. Types of metamorphism
3. Main metamorphic facies

H. Rock Cycle

I. Stratigraphy

1. Concept of relative chronology
2. Radiometric dating
3. Stratigraphic scale

Practical Work

PW 1: Topographic Mapping

a) Geographic and topographic coordinates

b) Principles of relief projection using contour lines and spot heights

c) Principles of constructing a topographic profile, application exercises for different slope types (various gradients), and slope calculation

d) Presentation of topographic maps and contour line systems

e) Profile exercises showing different types of summits, valley morphologies, and cliffs (map-based exercises)

f) Topographic profiles drawn from various maps

PW 2: Mineralogy

a) Crystallography and mineralogy

b) Igneous rocks

c) Sedimentary rocks

d) Metamorphic rocks

PW 3: Geological Mapping

a) Presentation of geological maps and introduction to stratigraphy (geometric principles)

b) Principles of constructing a geological cross-section

c) Exercises on determining dip direction and calculating dip

d) Geological cross-section with horizontal layers

e) Geological cross-section with inclined layers

f) Geological cross-section with folded layers (map-based exercises)

Semester: 01
Teaching Unit: Fundamental
Subject: Chemistry 1 (General and Organic Chemistry)
VHS: h (C /T/TP)
Credits: 6
Coefficient: 3
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

Chemistry is the science of the matter that surrounds us. It is present in many sectors of the natural and life sciences. Its broad scope requires knowledge of the essential basicprinciples. The course introduces the necessary tools for a good understanding of the microscopic nature of matter. The objective of this part is the description and understanding of the structure of the atom and the molecule.

The thermodynamic approach applied to equilibria is then addressed to understand the corresponding macroscopic description, allowing comprehension of the concepts of acids and bases, redox reactions, precipitation, and complexation. The objective of this part is to provide the necessary foundations of chemistry in aqueous solutions.

Chemical kinetics provides information on the rate of transformations. Thus, the student understands why some reactions occur faster compared to others.

Knowledge of the electronic configuration of different atoms, the various types of bonds, and kinetics allows the introduction of organic chemistry. All these aspects are vital for a good understanding of this branch of chemistry, which is of great interest in biochemistry. The essential rules of systematic nomenclature, electronic effects, and isomerism allow the description of molecular structures and the prediction of their reactivity to understand the mechanism of a reaction.

Course Content:

STRUCTURE OF MATTER

1. **General Concepts**
    - States of matter
    - Homogeneous and heterogeneous mixtures

- Evidence of the atom, nucleus, and particles
- Element, simple substance, and compound
- Atomic mass and isotopy

2. **Nucleus and Radioactivity**
   - Mass defect, mass-energy equivalence
   - Cohesion energy and nucleus stability
   - Natural and artificial radioactivity
   - Decay law
3. **Periodic Classification of Elements**
   - Brief historical overview of the periodic table
   - Classification principle (period, group, block)
   - Quantum numbers
   - Electronic configuration, Lewis representation
   - Periodic properties (radius, electronegativity, ionization energy, affinity, polarizability, metallic and non-metallic character, oxidizing/reducing ability, acidic/basic, amphoteric)
4. **The Molecule**
   - Localized chemical bonds (covalent, ionic, polarized, metallic)
   - Lewis model and octet rule
   - Molecular geometry (VSEPR)
   - Physical bonds: Van der Waals interactions (Keesom, London, Debye forces), hydrogen bonding

5.Crystals

- Definition
- FCC and CC structures
- Molecular, ionic, and metallic crystals

ORGANIC CHEMISTRY

- Nomenclature
- Electronic effects (inductive and resonance)

- Stereochemistry (isomers, absolute and relative configurations, Cram, Newman, and Fischer representations)
- Reaction mechanisms (nucleophilic substitution, addition, elimination, electrophilic substitution)

Tutorials :

TD 1: Fundamental concepts of chemistry (atoms, molecules, gram-atoms, moles, concentration calculations)

TD 2: Nuclear stability and radioactivity

TD 3: Electronic configuration and periodic classification of elements

TD 4: Chemical bonds

TD 5: Nomenclature and stereochemistry

TD 6: Reaction mechanisms

Practical Works:

PW 1: Solution preparation

PW 2: Acid-base titration

PW 3: Precipitation titration

PW 4: Complexometric titration

PW 5: Redox titration

PW 6: Molecular models

Semester: 01
Teaching Unit: Methodology
Subject: Physics 1 (Mechanics and Electricity)
VHS: h (C /T/TP)
Credits: 5
Coefficient: 3
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

This program aims to provide first-year students of the Preparatory School of Natural and Life Sciences with the theoretical foundation necessary for carrying out experimental setups and measurements. The first part of this module is devoted to classical mechanics.

The objective of this course is to deepen and consolidate the knowledge already acquired by students in high school. New concepts are introduced, such as momentum, angular momentum, and energy. In the thermodynamics section, the goal is to define essential basic concepts, such as temperature, heat, and the ideal gas law.

Course Content:

GENERAL MECHANICS

Chapter I: Dimensional and Vector Analysis

- Quantities, units, systems of units: MKSA, CGS
- Dimensional equations, dimensional analysis
- Error calculation: errors, uncertainties, sources of errors, calculation of uncertainties (absolute and relative)
- Main coordinate systems: Galilean frame, Copernican frame, geocentric frame, terrestrial frame
- Coordinates in 1D, 2D, and 3D; polar coordinates

Chapter II: Kinematics of a Point

- Rectilinear motion
- Sinusoidal rectilinear motion

Chapter III: Dynamics of a Particle

Chapter IV: Work and Energy

Chapter V: Dynamics of Rotational Motion (Angular Momentum)

Chapter VI: Statics of a Rigid Body

THERMODYNAMICS

Chapter I: Heat

- Thermometry
- Temperature scales: Celsius, Kelvin, and Fahrenheit
- Calorimetry
- Heat transfer: conduction, convection, and radiation

Chapter II: Ideal Gas

- Description
- Kinetic temperature
- Equation of state
- Internal energy and heat capacities
- Real gases (qualitative approach, Van der Waals equation)
- Mixtures of ideal gases
- The concept of compressibility and expansion of a fluid

Chapter III: General Principles of Thermodynamics

- Thermodynamic system
- Thermodynamic variables
- Thermodynamic equilibrium state
- Transformations of a thermodynamic system
- States of a pure substance (critical point, triple point, liquid-vapor equilibrium)

Chapter IV: Solid

- Definition, center of gravity, momentum, and angular momentum
- Statics: equilibrium of a solid and conditions of equilibrium in a Galilean frame

Chapter V: Open Systems

- Definition
- Mass balance
- First law
- Thomson steady-state regime

- Description of the components of a thermal machine using the concept of an open system

Chapter VI: Free Energy and Gibbs Free Energy

- Relations between state functions for a closed, single-phase system of fixed composition
- Gibbs–Helmholtz relation (free energy of ideal gases)

ELECTRICITY

Chapter I: Electrostatics

- Electrification phenomena, point charge, and Coulomb's law
- Electric field, potential, and potential energy
- Electric dipole
- Electrical conductor
- Electrostatic induction, capacitor

Chapter II: Electrokinetics

- Breakdown of electrostatic equilibrium, electric current
- Steady current, electric generator
- Ohm's law, resistance, and combinations of resistors
- Joule's law
- Electrical generators and receivers
- Electrical circuits and networks
- Network analysis: Kirchhoff's laws and applications

Chapter III: Electromagnetism

- Electromagnetism in a vacuum
- Electromagnetic field: properties
- Biot–Savart law
- Magnetic field produced by different circuit shapes (wire, loop, coil)
- Ampère's theorem
- Sinusoidal alternating current, use of complex numbers for parallel circuits, impedance calculation, Ohm's law

Tutorials:

TD 1: Exercises on dimensional analysis and error calculation

TD 2: Exercises on light propagation, plane diopters, and the prism

Practical Works:

PW 1: Calculation of uncertainties

PW 2: Simple pendulum: experimental determination of gravitational acceleration

PW 3: Kinematics: study of rectilinear motion, calculation of velocity and acceleration, determination of the nature of motion

PW 4: Measurement of resistance using a voltmeter and ammeter; verification of Ohm's law; assembly of series and parallel circuits; verification of Kirchhoff's laws; use of the oscilloscope

Semester: 01
Teaching Unit: Methodology
Subject: Mathematics 1
VHS: h (C /T)
Credits: 4
Coefficient: 2
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

The objective of teaching mathematics is twofold. On one hand, it contributes to deepening general scientific culture by providing students with access to fundamental areas such as linear algebra, analysis, and probability. The practice of mathematical reasoning plays a key role in shaping the mindset of a future scientist. Rigor in reasoning, critical thinking, verification and analysis of hypotheses, as well as observation and deduction skills, are specifically developed through mathematics.

Course Content:

MATHEMATICAL ANALYSIS

Chapter 1: Numerical Sequences

- Convergence and divergence of numerical sequences
- Recursive sequences
- Application of sequences to solving equations f(x)=0 (bisection and Newton methods)

Chapter 2: Differentiable Functions

- Concept of derivative and differential of a real-valued function; basic operations on differentiable functions
- Theorems on differentiable functions: Rolle's theorem
- Mean value theorem, Cauchy's theorem, and L'Hôpital's rule (limit calculation)
- Application: finding extrema of a function of one real variable

Chapter 3: Inverse Functions of Trigonometric and Hyperbolic Functions

- Trigonometric functions and their inverses (arccos, arcsin, arctan)
- Hyperbolic functions and their inverses (arcosh, arsinh, artanh)

Chapter 4: Taylor Expansions

- Comparison of functions near a point: negligible functions, Landau notation o, equivalent functions
- Functions of class c n - Taylor and Maclaurin formulas; definition and computation of Taylor expansions of usual functions
- Operations on expansions (sum, product, quotient, composition, differentiation, integration)
- Applications: limit calculation, curve position relative to an asymptote, approximations

Chapter 5: Integration

- Definition and properties of the Riemann integral
- Theorems on definite integrals: first and second mean value theorems; Cauchy–Schwarz inequality
- Calculation of antiderivatives: substitution method, integration by parts, rational functions, trigonometric functions
- Improper integrals; study of Gamma and Beta functions

Chapter 6: Differential Equations

- First-order differential equations (separable variables, homogeneous equations, reducible to homogeneous, total differential equations)
- First-order linear differential equations: variation of constants method
- Equations of the form $x=f(y')$ and $y=g(y')$
- Second-order linear differential equations with constant coefficients

Tutorials:

TD1: Experimental study of sequence convergence (numerical study of arithmetic, geometric, and recursive sequences)

TD2: Differentiation and graphical interpretation (derivatives of standard and composite functions)

TD3: Rolle's theorem, mean value theorem, and Cauchy's theorem (graphical illustration)

TD4: Study of inverse trigonometric and hyperbolic functions (graphical and numerical equation solving)

TD5: Taylor expansions and function approximation (second- or third-order expansions of common functions)

TD6: Integration and numerical area calculation (various methods: substitution, integration by parts, etc.)

TD7: Improper integrals (convergence study)

TD8: Numerical solution of ordinary differential equations (simple first-order equations)

Semester: 01
Teaching Unit: Discovery
Subject: Universal History of Biological Sciences
VHS: h (C)
Credits: 1
Coefficient: 1
Evaluation method: Continuous assessment: 100%

Training Objectives:

This course aims to trace the major stages in the evolution of biological sciences across different historical periods and civilizations, highlighting the interactions between technological progress, scientific discoveries, and cultural or philosophical contexts. The objectives are to:

- Understand the evolution of fundamental biological concepts from prehistory to the contemporary era.
- Identify the major figures, schools of thought, and key discoveries that have shaped biology.
- Place scientific advances within their historical, cultural, and technological contexts.
- Develop a critical and historical perspective on science, particularly in its applications to life sciences and agronomy.

Course Content:

I. Origins of Biological Thought: Prehistory

- Empirical practices related to nature, food, and primitive medicine.
- Early knowledge related to plant and animal reproduction.

II. Antiquity: Emergence of Biological Concepts

- Ancient Egypt, Mesopotamia, India, China: early classifications, medicine, and pharmacopoeia.
- Ancient Greece: Hippocrates, Aristotle, and the systematization of naturalistic observations.
- Ancient Rome: Galen and the synthesis of medical knowledge.

III. The Middle Ages

- Christian West: limited transmission of Greco-Roman knowledge.

- Islamic world: preservation and development of biology (Avicenna, Al-Razi, Ibn al-Nafis…).
- First hospitals, herbals, and systematic medical writings.

IV. 16th and 17th Centuries: Renaissance and Scientific Revolution

- Rediscovery of ancient texts and development of printing.
- First human dissections and study of plants for medical purposes.
- Invention of the microscope (Leeuwenhoek, Hooke) and exploration of the invisible world.

V. 18th Century: Systematization and Early Models

- Linnaeus and the binomial classification of species.
- Buffon, Lamarck, and early hypotheses on the transformation of living beings.
- Darwin (19th century): theory of evolution by natural selection (influenced by 18th-century naturalists).

VI. 19th Century: Foundations of Modern Biology

- Cell theory (Schleiden, Schwann), experimental embryology, animal and plant physiology.
- Birth of genetics: Mendel's work.
- Early foundations of immunology and microbiology (Pasteur, Koch), and experimental biology.

VII. 20th Century: Explosion of Knowledge and Biotechnologies

- Discovery of DNA, molecular biology, protein structure.
- Development of molecular genetics and the Human Genome Project.
- Cloning, gene therapy, GMOs: between scientific advances and ethical debates.
- Emergence of integrative biology, bioinformatics, and green biotechnology.

Semester: 01
Teaching Unit: Discovery
Subject: Computer science 1 (Open-source Software)
VHS: h (PW)
Credits: 1
Coefficient: 1
Evaluation method: 100% Continuous assessment

Teaching objective:

This course aims to introduce students to the fundamental concepts of computer science by providing a clear understanding of computer hardware architecture, operating systems, and main software applications. It enables students to master essential office tools such as Microsoft Word and Excel, for effective use in academic and scientific contexts. Emphasis is placed on practical skills required for information management and processing.

Course content:

1. Introduction to computer science

1.1. Concept of information
1.2. Information processing
1.3. Information processing model
1.4. Difference between hardware and software

2. Computer hardware architecture (HARDWARE)

2.1. Motherboard: role and connections
2.2. Processor (CPU): basic functioning
2.3. Random Access Memory (RAM)
2.4. Read-Only Memory (ROM)
2.5. Storage devices: hard drives (HDD, SSD), USB, CD/DVD
2.6. Graphics card (GPU)
2.7. Input/output devices: keyboard, mouse, screen, printer

2.8. Expansion cards: sound card, network card

2.9. Internal buses and connectors

3. Operating systems and software

3.1. Definition of an operating system

3.2. Introduction to Windows

3.3. Use of desktop, windows, and icons

3.4. File and folder management

3.5. Use of mouse and keyboard

3.6. Types of software (system, application, utilities)

3.7. Software installation and uninstallation

4. Office tools – Word processing (Microsoft Word)

4.1. Introduction to the Word interface

4.2. Text entry and formatting

4.3. Inserting elements: tables, images, charts

4.4. Page layout, headers/footers

4.5. Printing and exporting

5. Office tools – Spreadsheet (Microsoft Excel)

5.1. Introduction to the Excel interface

5.2. Data entry and manipulation

5.3. Cell and table formatting

5.4. Basic formulas and common functions (SUM, AVERAGE, IF…)

5.5. Creating and customizing charts

5.6. Simple statistical functions

5.7. Practical applications in data management

Semester: 01
Teaching Unit: Transversal
Subject: Techniques of communication and expression in English 1
VHS: h (C)
Credits: 1
Coefficient: 1
Evaluation method: 100% Exam

Training Objectives:

This course is designed to develop the essential English language skills of non-native speakers in a scientific context, with a particular focus on the life and agricultural sciences. The main objectives are:

• Acquire fundamental grammatical structures necessary to produce accurate English sentences.
• Develop oral communication skills, with particular emphasis on accurate pronunciation and spoken fluency.
• Build thematic vocabulary related to biology, agronomy, environment, and animal sciences.
• Introduce students to scientific and professional writing techniques, such as reports, cover letters, and oral presentations.
• Enhance comprehension of scientific documents in English (texts, articles, manuals).

Course Content:

Chapter 01 : Introduction to language

- ✓ What is language?
- ✓ Properties and functions of language
- ✓ Overview of the English language
- ✓ Characteristics of scientific English

Chapter 02; Effective communication

The English Sound System

- ✓ Introduction to phonetic symbols (IPA – International Phonetic Alphabet)
- ✓ Phonetic transcription: oral and written exercises

Basic Communication Structures

- ✓ Asking and answering questions
- ✓ Introducing oneself and presenting one's academic background

- ✓ Expressing opinions, ideas, and preferences

Chapter 3: Thematic Vocabulary in Agronomy

Word Formation in Scientific English

- ✓ Common roots, prefixes, and suffixes

Lexical Themes

- ✓ *Nature and environment*: climate, soil, water, biodiversity
- ✓ *Plants*: vocabulary related to morphology, anatomy, physiology
- ✓ *Animals*: terms related to classification, breeding, and animal biology
- ✓ *Professions and tools in agronomy*
- ✓ *Useful phrases for internships, reports, and presentations*

Chapter 4: Writing Techniques

Short Text Composition

- ✓ Descriptions of plants, animals, and agricultural processes
- ✓ Summaries of scientific documents

Professional Writing Techniques

- ✓ Internship reports
- ✓ Cover letters and application emails
- ✓ Scientific presentation planning and writing

Introduction to Critical Reading

- ✓ Identifying the structure and purpose of scientific texts
- ✓ Recognizing key arguments, hypotheses, and conclusions
- ✓ Vocabulary inference and comprehension strategies

2nd Semester

Semester: 02
Teaching Unit: Fundamental
Subject: Plant Biology
VHS: h (C/PW)
Credits: 6
Coefficient: 3
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

The plant biology section aims to provide students with fundamental knowledge about the plant world. In this same spirit, the various chapters of this unit will allow for the study of plant classification and the distinctive morphological and histological characteristics between lower and higher plants. First, a study of the morphological organization of the vegetative and reproductive systems of plants is presented. Subsequently, a histological study is offered to students, which will begin by discussing the cytological characteristics of primary meristematic cells and the different primary tissues (lining, filling, supporting, and vascular tissues). Secondary meristems and secondary tissues will also be addressed in this section. These two chapters will be followed by the study of primary and secondary anatomy, which will allow students to synthesize this histological study of higher plants.

Course content:

CHAPTER 1 – Classification of Plants

1.1. General concepts of classification

1.2. Classification criteria

CHAPTER 2 – Morphology and Adaptation of Higher Plants (Angiosperms)

2.1. The root

2.2. The leaf

2.3. The stem

2.4. The flower

CHAPTER 3 – Histology of Higher Plants (Angiosperms)

3.1. Primary meristems

- 3.1.1. Localization
- 3.1.2. Roles
- 3.1.3. Cytological characteristics

3.2. Primary tissues

- 3.2.1. Protective tissues
- 3.2.2. Parenchyma tissues
- 3.2.3. Supporting tissues
- 3.2.4. Secretory tissues
- 3.2.5. Conducting tissues

3.3. Secondary meristems

- 3.3.1. Localization
- 3.3.2. Roles
- 3.3.3. Cytological characteristics

3.4. Secondary tissues

- 3.4.1. Conducting tissues
  - Establishment and functioning of the cambium in the stem and root (in dicotyledonous angiosperms)
- 3.4.2. Secondary protective tissues

CHAPTER 4 – Anatomy of Higher Plants (Angiosperms)

4.1. Primary anatomy

- 4.1.1. Stem
- 4.1.2. Root
- 4.1.3. Comparison of primary anatomies
- 4.1.4. Leaf

4.2. Secondary anatomy

Practical work

PW 1: Morphological organization of the vegetative apparatus of Angiosperms

PW 2: Primary protective tissues

PW 3: Parenchyma and supporting tissues

PW 4: Primary conducting tissues

PW 5: Tissues of secondary origin

PW 6: Flower morphology in Angiosperms

Semester: 02
Teaching Unit: Fundamental
Subject: Animal Biology
VHS: h (C/PW)
Credits: 6
Coefficient: 3
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Part I: Histology

Training Objectives:

The teaching of Histology is devoted to the morphological (topographical and structural) and histophysiological study of the tissues and organs of domestic animals. It should enable students to acquire the basic knowledge necessary for understanding other subjects, particularly Physiology. The teaching of Histology should enable students to:

- Know the fundamental techniques for the preparation and observation of biological tissues.
- Identify and characterize the different types of tissues (epithelial, connective, muscular, nervous).
- Understand the structure–function relationships at the cellular and tissue levels.
- Be able to interpret a simple histological slide.

Course Content:

1. Introduction to Histology

- Definitions and general organization of tissues

2. Epithelial Tissues

- Covering epithelia: shapes, locations, functions
- Glandular epithelia: exocrine and endocrine glands, modes of secretion
- Classification criteria (number of layers, cell shape, specialization)

3. Connective Tissues

- Components of connective tissues
- Classification of connective tissues

- Loose and dense connective tissue
- Adipose tissue
- Reticular tissue
- Fixed and mobile cells of connective tissue
- Extracellular matrix: fibers (collagen, elastic, reticular), ground substance

4. Skeletal Tissues

- Cartilaginous tissue: hyaline, elastic, fibrous
- Bone tissue: compact bone (osteon structure), spongy bone, bone cells (osteoblasts, osteocytes, osteoclasts)

5. Muscular Tissues

- Skeletal striated muscle: structure of the muscle fiber
- Smooth muscle: organization and location
- Cardiac muscle: intermediate characteristics

6. Nervous Tissue

- Neurons: structure, types
- Glial cells
- Synapse and transmission of nerve impulses
- Histological organization of gray and white matter (overview)

Practical Work

- **PW1:** Histological study methods: sections, staining, observation
- **PW2:** Observation of epithelia and glands (covering, exocrine, endocrine)
- **PW3:** Observation of connective tissues
- **PW4:** Observation of bone and cartilaginous tissues
- **PW5:** Observation of nervous and muscular tissues
- **PW6:** Observation of a blood smear

Part II: Embryology

Training Objectives:

Embryology, or developmental biology, is one of the biological disciplines that is currently experiencing considerable progress thanks to the renewal of traditional methodological approaches aimed at understanding how a new organism is formed.

The main objective of the embryology course is to explore the process by which a pluripotent fertilized cell develops into a complete organism composed of highly differentiated cells and tissues.

Emphasis is placed on the dynamic (spatial and temporal) aspects of all stages: fertilization, cleavage, implantation and placentation, gastrulation, neurulation, and organogenesis.

Course Content:

1. Introduction to Embryology

- Definitions and significance

2. Gametogenesis

- Spermatogenesis: stages, cells, duration
- Oogenesis: folliculogenesis, meiosis, ovulation

3. Fertilization

- Mechanisms of gamete encounter
- Capacitation, recognition, and gamete fusion reactions
- Oocyte activation and initiation of development
- Blocks to polyspermy (species-specific)

4. Stages of Embryonic Development

a) Implantation: Example: Humans

b) Pre-gastrulation

c) Gastrulation

- Definition

- Morphogenetic movements

  d) Neurulation in humans

  e) Neurulation in the chicken

  f) Organogenesis

- Definition

5. Formation of Embryonic Annexes in the Chicken

1. Formation of the yolk sac
2. Formation of the allantois
3. Formation of the amnion

6. Formation of Embryonic Annexes in Humans

1. Formation of the umbilical cord
2. Formation of the placenta
3. Formation of the amnion

Practical Work

- **PW1:** Spermatogenesis: observation of a cross-section of a testis (slide)
- **PW2:** Folliculogenesis: observation of a cross-section of an ovary (slide)
- **PW3:** Observation of development in birds at 24h, 36h, and 48h
- **PW4:** Gastrulation and neurulation in amphibians
- **PW5:** Gastrulation and neurulation in sea urchin

Semester: 02
Teaching Unit: Fundamental
Subject: Chemistry 2 (Thermodynamics and Solution Chemistry)
VHS: h (C /T/TP)
Credits: 6
Coefficient: 3
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

This course aims to provide students with a solid foundation in chemical thermodynamics, solution chemistry, and chemical kinetics. It enables them to understand the principles governing chemical transformations, predict the behavior and evolution of chemical systems, and analyze reaction mechanisms under different conditions. Students will develop the theoretical and practical skills necessary to study chemical equilibria, reaction rates, and physicochemical processes commonly encountered in chemistry and related scientific fields.

Course Content:

Chapter 1: Chemical thermodynamics

- Characteristic principles of a chemical reaction: chemical equation, stoichiometry, conservation
- Progress of a chemical reaction
- Prediction of the direction of a chemical system
- Chemical equilibria
- Thermodynamic constant at equilibrium
- Chemical composition at equilibrium
- Equilibrium shift (influence of temperature, pressure, addition of active or inert components)

Chapter 2: Chemistry in solution

- Acids and bases
- Redox reactions
- Precipitation
- Complexes

Chapter 3: Chemical kinetics

- Reaction rate (homogeneous system at constant volume), rate law, reaction order (overall and partial), rate constant
- Order degeneracy: cases where one reactant is in large excess, particularly when this reactant is the solvent
- Half-life
- Application to zero, first, and second-order reactions
- Arrhenius law
- Determination of order (graphical, differential, and numerical methods)

Tutorials:

TD 4: Chemical bonds

TD 5: Nomenclature and stereochemistry

TD 6: Reaction mechanisms

Practical works

TP 4: Complexometric titration

TP 5: Redox titration

TP 6: Molecular models

Semester: 02
Teaching Unit: Methodology
Subject: Physics 2 (Optics and Fluid Mechanics)
VHS: h (C /T/TP)
Credits: 5
Coefficient: 3
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

This program aims to provide first-year students of the Preparatory School of Natural and Life Sciences with the theoretical foundation necessary for carrying out experimental setups and measurements. The first part of this module is devoted to mechanics within its classical framework.

The objective of this course is to deepen and consolidate the knowledge already acquired by students in high school. New concepts are introduced, such as momentum, angular momentum, and energy. In the thermodynamics section, the objective is to define the strictly essential basic notions, such as temperature, heat, and the ideal gas law.

Course Content:

OPTICS

Chapter I: Introduction to the Phenomenon of Light

Chapter II: Geometrical Optics

Chapter III: Elements of Geometrical Optics

1. General concepts: origin, light beam, reflection, refraction, notion of object and image
2. Descartes' and Snell's laws
3. Mirrors (plane and spherical)
4. Diopters (plane and spherical)
5. Parallel-faced plate, prism, spherical lenses

6. Centered optical systems

Chapter IV: Optical Instruments

1. The eye: reduced eye, field of vision, resolution, ametropia and correction
2. Magnifying glasses (simple and compound), microscope, telescopes (terrestrial and astronomical), telescope

FLUID MECHANICS

Chapter I: Introduction

1. Matter and molecular interaction forces
2. Fluid state
3. Mass density and relative density (liquids and gases)
4. Continuous aspect of a fluid, fluid particle
5. Fluid equilibrium

Chapter II: Hydrostatics

1. Definition of pressure in a liquid
2. Laws of hydrostatics and applications
3. Principle of communicating vessels
4. Pascal's theorem, hydraulic press
5. Archimedes' principle, buoyancy
6. Pressure measurement: barometer, manometer
7. Surface tension and capillary phenomena
8. Surface phenomena
9. Surface tension force
10. Contact between a liquid, a solid, and a gas (wetting phenomenon)
11. Applications: additional pressure, capillary embolism, stalagmometry, Jurin's law

Chapter III: Hydrodynamics

1. Definitions: fluid in motion, mass density of a fluid particle, trajectory, stream tube
2. Law of mass conservation
3. Part B: Perfect Fluid
4. Definition
5. Bernoulli's equation and applications
6. Chapter IV: Interactions in Fluids
7. Transport phenomena
8. Molecular diffusion
9. Study of binary solutions

Tutorials

TD 1: Exercises on spherical diopters and thin lenses.

TD 2: Exercises on plane and spherical mirrors and the reduced eye.

TD 3: Exercises on Pascal's law and Archimedes' buoyant force (Hydrostatics).

TD 4: Exercises on Bernoulli's law (Hydrodynamics).

Practical work

PW1: Dispersion of light by a prism (spectrogoniometer)

PW2: Reflection and refraction

PW3: Thin lenses

Semester: 02
Teaching Unit: Methodology
Subject: Mathematics 2 (Algebra)
VHS: h (C /T)
Credits: 4
Coefficient: 2
Evaluation method: Continuous assessment: 40 % Exam: 60 %.

Training Objectives:

The objective of mathematics teaching is twofold.

On the one hand, it contributes to the deepening of general scientific culture by giving students access to some fundamental fields (linear algebra, analysis, probability). The practice of mathematical reasoning contributes, as in other disciplines, to the intellectual development of a future scientist. The rigor of reasoning, critical thinking, verification and analysis of hypotheses, as well as the sense of observation and deduction, find in mathematics a field where they are specifically cultivated.

Course Content:

Chapter 1: Vector Spaces over a Field K (K = C or K = R)

- Definition of a vector space and elementary calculations on vector spaces.
- Vector subspaces: Definition — Intersection, sum, and direct sum of vector subspaces.
- Bases and dimension of a vector subspace.

Chapter 2: Linear Applications (Finite-Dimensional Case)

- Definition and properties of linear applications.
- Image — Kernel and rank of a linear application.

Chapter 3: Matrix Calculus

- Matrix associated with a linear application.
- Operations on matrices.
- Determinants: Definition and elementary operations on determinants.
- Invertible matrices — Application to solving a Cramer system.
- Change of basis — Similar matrices.
- Eigenvalues, eigenvectors, and matrix diagonalization.

Tutorials

TD1: Vector spaces and elementary calculations
TD2: Vector subspaces (Determination of a vector subspace from a given set)
TD3: Basis, spanning set, and dimension (Linear independence test)
TD4: Linear applications: definitions and examples (Verification that an application is linear)
TD5: Image, kernel, and rank of a linear application (Calculation of the kernel and image of a given application)
TD6: Matrix calculus: operations and associated matrices
TD7: Determinants and invertible matrices (Calculation of determinants of order 2 and 3)
TD8: Diagonalization and change of basis (Calculation of eigenvalues and eigenvectors of a 2×2 or 3×3 matrix)

Semester: 02
Teaching Unit: Discovery
Subject: Supervised Personal Work – Methodology
VHS: h (C)
Credits: 1
Coefficient: 1
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

This module aims to train students in the fundamentals of the scientific approach and documentary research, providing them with the necessary methodological tools to carry out independent, well-structured, and well-argued work. It also introduces them to scientific communication, both written and oral, as well as the use of digital resources.

This course serves as a progressive introduction to research, adapted to the Bachelor's level, and prepares students for the requirements of final-year projects or applied research in the fields of agronomy, biology, or environmental sciences.

Module Content:

1. General Work Methodology

- Organization of group work and project management
- Development of academic skills and interpersonal attitudes in an academic context
- Use of scientific materials (tables, graphs, maps, diagrams, etc.)
- Effective and structured note-taking
- Self-assessment: monitoring personal progress
- Topic analysis and argument development
- Techniques for synthesis and solving simple scientific problems
- Writing a scientific document (report, synthesis, technical sheet)
- Scientific commentary of a figure or illustrated document

2. Documentary Research

- Introduction to bibliographic research (catalogs, databases, specialized search engines)
- Use of university libraries and online resources
- Evaluation of source reliability (scientific, technical, popularized sources)

3. Reading and Critical Analysis of Scientific Articles

- Understanding the structure of a scientific article (abstract, introduction, methodology, results, discussion)
- Identifying the research problem, hypotheses, results, and their implications
- Summarizing, commenting on, and discussing a scientific article

Semester: 02
Teaching Unit: Discovery
Subject: Computer science 2 (Introduction to Artificial Intelligence)
VHS: h (PW)
Credits: 1
Coefficient: 1
Evaluation method: 100% Continuous assessment

Teaching Objective:

This course aims to introduce students to the fundamental concepts of computer science by providing them with a clear understanding of computer hardware architecture, operating systems, and major software applications. It will enable them to master essential office tools such as Microsoft Word and Excel for effective use in academic and scientific contexts. Emphasis is placed on practical skills necessary for information management and processing.

Course Content:

1. Statistical Tools (Excel or Other Software)

1.1. Introduction to descriptive statistics
1.2. Data organization
1.3. Data analysis and visualization (histograms, curves, means, medians)
1.4. Use of statistical formulas and functions
1.5. Graphical presentation of results

2. Introduction to Artificial Intelligence (AI)

2.1. What is artificial intelligence?
2.2. Fields of AI application
2.3. Main branches of AI: machine learning, deep learning
2.4. Examples of accessible AI tools (ChatGPT, Gemini, Copilot, etc.)

3. Artificial Intelligence in Scientific Research

3.1. Use of AI for scientific monitoring and literature review
3.2. AI-assisted scientific data analysis

3.3. AI for writing reports, summaries, and publications

3.4. Automation of repetitive tasks in research projects

4. AI for Idea Development and Creativity

4.1. AI tools for brainstorming and idea generation

4.2. Assistance in project structuring (mind mapping, diagrams)

4.3. AI-assisted visualization

4.4. Ethics and limitations of AI in human creativity

Semester: 02
Teaching Unit: Transversal
Subject: Communication and expression techniques in French
VHS: h (C)
Credits: 1
Coefficient: 1
Evaluation method: 100% Exam

Training Objectives:

This course aims to develop in students the linguistic, methodological, and cultural skills necessary for academic success in a French-speaking environment, particularly in scientific disciplines. More specifically, students will learn to:

- Understand lectures, audio materials, and specialized written documents.
- Extract, organize, and reformulate relevant information.
- Acquire the methodological foundations of note-taking, summarizing, and scientific writing.
- Develop clear, structured written and oral expression adapted to academic and professional situations.

Course Content:

Sequence 1: Developing Active Listening Strategies

1. Understand the general meaning of an audio document or lecture.
2. Identify the outline or logical structure of a presentation.
3. Recognize keywords, connectors, and discourse markers.

Sequence 2: Reading and Interpreting a Scientific Diagram

1. Identify the types of diagrams used in agronomy, biology, or environmental sciences.
2. Access the informational and functional content of a diagram.
3. Describe, explain, and use a diagram in written or oral production.

Sequence 3: Understanding and Building Scientific Vocabulary

1. Break down a scientific term: root, prefix, suffix.
2. Create or understand scientific neologisms.
3. Precisely define a term within its disciplinary context.

Sequence 4: Speed Reading and General Understanding of Scientific Texts

1. Identify the role of the title, introduction, and conclusion.
2. Determine the structure of a scientific text.
3. Use introductory sentences to anticipate the content of paragraphs.

Sequence 5: Analytical and In-Depth Reading

1. Identify the type of text (explanatory, descriptive, argumentative, etc.).
2. Distinguish the different sections and their functions (hypothesis, demonstration, results, etc.).
3. Analyze an informative or argumentative text in terms of its logical coherence.

2nd Year

3rd Semester

Semester: 03
Teaching Unit: Fundamental
Subject: Plant physiology
VHS: h (C/T/PW)
Credits: 6
Coefficient: 4
Evaluation method: continuous assessment: 40 % Exam: 60 %.

Training Objectives:

Plant physiology studies the life of plants in their functional dimensions while also taking into account structural aspects. Function is closely dependent on structure; indeed, it is necessary to understand the ultrastructure or chemical properties of a cell unit in order to highlight the relationship between plant structure and function. The first part addresses nutrition, namely water, mineral, and carbon, while the second part deals with plant growth and development.

Course Content:

Chapter I: Water Nutrition

1. Water flow, from entry through the roots (root absorption) to leaf transpiration (stomatal functioning)
2. Water balance in the plant
3. Transport of raw and elaborated sap

Chapter II: Mineral Nutrition of Plants

1. Mineral composition of plants (macroelements and trace elements)
2. Plant requirements, quantitative aspects, and usable forms
3. Mineral deficiency and toxicity
4. Nitrogen nutrition
5. Sources and cycle of nitrogen
6. Assimilation of atmospheric nitrogen

Chapter III: Photosynthesis

1. The light phase:
2. Localization of photosynthesis: chloroplasts
3. Light absorption: photosystems

4. Cyclic photophosphorylation
5. Non-cyclic photophosphorylation
6. The dark phase (Calvin cycle)
7. Overall photosynthesis balance
8. Comparison of photosynthesis in C3, C4, and CAM plants

Chapter IV: Cellular Respiration

1. Aerobic respiration
2. Glycolysis
3. Krebs cycle
4. Oxidation in the respiratory chain
5. Overall balance of aerobic respiration
6. Fermentation
7. Photorespiration

Chapter V: Growth and Development

1. Seeds and germination
2. Reserves (nature and formation)
3. Seed dormancy and dormancy breaking
4. Germination
5. Vegetative development
6. Growth and development of the aerial parts
7. Growth and development of the root system
8. Reproductive development
9. Floral transition
10. Hormonal regulation of growth and development
11. Nature and functions of natural hormones

Practical work

PW1: Water in plants: Osmotic effect

PW2: Extraction and quantification of different photosynthetic pigments

PW3: Respiration

PW4: Seed germination (mono- and dicotyledons)

PW5: Amylase activity

Tutorials

TD1: Water absorption and release in plants

TD2: Nitrogen and mineral nutrition

TD3: Energy nutrition

TD4: Chlorophyll assimilation

TD5: Development, growth, and fruit maturation

Semester: 03
Teaching Unit: Fundamental
Subject: Biochemistry 1
VHS: h (C/T/PW)
Credits: 7
Coefficient: 4
Evaluation method: continuous assessment: 40 % Exam: 60 %.

Training Objectives:

Biochemistry lies at the interface between biology and chemistry. It concerns the study of the structure and function of biomolecules and multimolecular complexes. This course will enable students to acquire several competencies:

Understand how a living organism is organized at the molecular level using appropriate terminology.

Understand the regulatory mechanisms of physiological and pathophysiological processes through knowledge of the structure of macromolecules and their interactions.

Identify appropriate experimental approaches for the study of macromolecules through mastery of classical experimental methods (spectrophotometric assays, electrophoresis), thereby meeting the requirements of research and development in life and natural sciences in the fields of biotechnology, agronomy, environmental biology, marine biology, etc.

Course Content:

Chapter I: Carbohydrates

Introduction

Classification of carbohydrates

I. Monosaccharides

- Representation of monosaccharides
    a. Fischer projection
    b. Haworth projection: cyclization of monosaccharides
- Physicochemical properties of monosaccharides
- Derivatives of monosaccharides

II. Osides

Chapter II: Lipids

Classification of lipids

I. Simple lipids

a. Fatty acids

b. Glycerides

c. Cerides

d. Sterides

II. Complex lipids (unsaponifiable)

- Glycerophospholipids
- Sphingolipids

Chapter III: Proteins

I. Amino acids

- Formulas and classification
- Properties

II. Peptides

- Nomenclature
- Ionization
- Physicochemical properties
- Determination of peptide structure

III. Three-dimensional structure of proteins

Chapter IV: Enzymology

1. General concepts
2. Properties of enzymes
3. Structure of enzymes
4. Nomenclature and classification
5. Enzyme kinetics
   - Michaelis–Menten hypothesis
6. Catalytic activity
   - Units of enzymatic activity
   - Effectors of catalytic activity

a. Activators

b. Inhibitors

7. Non-Michaelian kinetics: allosteric enzymes

Tutorials

TD1: Understanding the structure of carbohydrates

(Identify and represent monosaccharides and osides, understand their classification and main properties).

TD2: Identifying the different types of proteins

(Distinguish protein classes, recognize their structures, and understand their biological functions).

TD3: Identifying the different types of lipids

(Distinguish lipid classes (simple and complex), recognize their structures, and understand their biological functions).

TD4: Enzymatic activity

Practical work

PW1: Characterization and quantification of carbohydrates (volumetric methods)

PW2: Study of carbohydrates (optical rotation and quantification)

PW3: Lipid analysis

PW4: Study of proteins (quantification and separation)

PW5: Analysis of amino acids and enzymatic activity

PW6: Quantification of vitamin C

Semester: 03
Teaching Unit: Fundamental
Subject: Zoology
VHS: h (C/T/PW)
Credits: 6
Coefficient: 4
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

This unit addresses a fundamental question asked by students: “What is it?” and enables them to determine whether what they observe is already known and described.
It involves managing classification in both a pedagogical and scientific manner. It deals with the biology of observed species within major groups and their morphology, without placing too much emphasis on their internal anatomy.
To facilitate memorization, scientific concepts related to species, genera, families, and orders are systematically broken down into their Greek and Latin etymological roots and then explained.
The course is also illustrated with a large number of diagrams on external morphology and biological cycles, which supports this approach.

Course Content:

Introduction

Chapter 1: Presentation of Zoology

1. Definition
2. History
3. Principle of classification
4. Current taxonomy or systematics
5. Zoological classification
6. Nomenclature
7. Importance of animal kingdom

Chapter 2: The Animal Reign (Kingdom)

Part 1: Protozoa

I. Definition
II. Unicellular characteristics

III. Structural organization of protozoa

IV. Nutrition, Excretion and Respiration

V. V. Reproduction

VII. Ecology

VIII. Systematics of protozoa

- 1.Subphylum Ciliophora
- 2.Subphylum Zoomastigophora
- 3.Subphylum Rhizopoda
- 4.Subphylum Apicomplexa
- 5.Subphylum Actinopoda
- 6.Subphylum Foraminifera

Part 2: Metazoa (invertebrates)

I. Diploblastic Metazoa

1. Phylum Spongiaria (Porifera)
2. Phylum Cnidaria
3. 3. Phylum Ctenophora

II. Triploblastic Metazoa

1. Phylum Plathelmintha
2. Phylum Nemathelmintha
3. Phylum Annelida
4. Phylum Mollusca
5. Phylum Arthropoda

Part 3: Metazoa (vertebrates)

- General concepts

Class: Cyclostomes

1. Morphology
2. Anatomy
3. Biology
4. Classification

Class: Chondrichthyans

1. External morphology
2. Anatomy
3. Skeleton
4. Biology
5. Classification

Class: Osteichthyans

1. External morphology
2. Anatomy
3. Biology
4. Classification

Class: Amphibians

1. General concepts
2. Study of the green frog
3. Morphology
4. Anatomy
5. Biology (frog and newt)
6. Metamorphosis
7. Neoteny
8. Classification

Class: Reptiles

1. General concepts
2. Morphology of the green lizard and the grass snake
3. Anatomy
4. Study of some biological characteristics of reptiles
5. Origin and classification of reptiles
6. Fossil reptiles

Class: Birds

1. General concepts
2. External morphology of the wood pigeon
3. Anatomy

4. Elements of biology
5. Classification of birds

Class: Mammals

1. General concepts
2. Morphology of the white rat
3. Anatomy
4. Biology
5. Classification of mammals

Transition from Aquatic to Terrestrial Environment in Vertebrates

1. Introduction
2. The integument
3. Respiration
4. Circulation
5. Locomotion
6. Excretion
7. Reproduction
8. The middle ear
9. Conclusion

Tutorials

TD1: Analysis of zoological classification criteria (Comparative study of fictional or real animal descriptions, identification of major diagnostic characteristics, construction of simple dichotomous keys, and classification of species into the appropriate taxonomic categories).

TD2: Scientific etymology and taxonomy (Work on a list of species belonging to the different phyla studied in class. Analysis of Greek and Latin roots of names (species, genus, order). Establishing relationships between names and biological or morphological characteristics. Exercise in creating scientifically justified fictional binomial names).

TD3: Comparative study of biological cycles (Analysis of diagrams or texts describing reproductive cycles in protozoa, flatworms, insects, and amphibians. Comparison of sexual/asexual reproduction methods, metamorphosis, and neoteny. Synthesis in the form of comparative tables. Discussion of evolutionary implications).

TD4: Transition from aquatic to terrestrial environments in vertebrates (Guided reading of documents describing major transformations (integument, respiration, skeleton, reproduction, middle ear, etc.). Relating these transformations to the corresponding vertebrate classes. Preparation of summary sheets or comparative diagrams. Multiple-choice questionnaires and open-ended synthesis questions).

Practical work

PW1: Study of freshwater protozoa (ciliates, Paramecium)

PW2: Identification of mollusks (Gastropoda, Bivalvia, and Cephalopoda)

PW3: Identification of arthropods (Arachnida, Myriapoda, Crustacea, and Insecta)

PW4: Identification of cartilaginous and bony fishes

PW5: Identification of amphibians and reptiles

PW6: Identification of birds and mammals

Semester: 03
Teaching Unit: Fundamental
Subject: Genetics
VHS: h (C/T/PW)
Credits: 6
Coefficient: 4
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training objectives:

The teaching of genetics to students of natural and life sciences aims to enable them to:

- Distinguish between prokaryotic and eukaryotic organisms, particularly through their genetic characteristics.
- Understand DNA as a central tool in molecular biology, used in techniques such as molecular hybridisation, transgenesis and cloning, without neglecting bacterial genetics.
- Recognise that certain mutations, affecting different levels of genetic organisation, can be detected by cytogenetic analyses such as karyotyping, in both plants and animals.
- Gain an understanding of the physical nature of DNA through practical work, in particular through the visual observation of its filamentous structure (or 'DNA jelly').
- Master the fundamental laws of Mendelian inheritance through applied exercises, thereby consolidating the prerequisites of classical genetics.

Course Content:

Chapter 1: General Overview of the Cell (Genetic Approach)

- Prokaryotes
- Bacteria
- Eukaryotes
- Fungi (haploid)
- Mammals (diploid)

Chapter 2: Structure of DNA

- Chromatin
- Chromosomes
- Genes
- DNA

Chapter 3: DNA replication and repair

- Replication
- DNA repair

Chapter 4: The cell cycle

- Mitosis
- Meiosis

Chapter 5: Mutations and their consequences

- Gene mutations
- Chromosomal mutations
- Genomic mutations

Chapter 6: Bacterial genetics

- Bacterial genotypic variations
- Concepts of phototrophic and auxotrophic bacteria
- Transfer of genetic material (bacterial conjugation)
- Concepts of crossing over (genetic recombination)
- Genetic regulation (inducible and repressible regulatory pathways)

Chapter 7: The karyotype

- Techniques for obtaining a human karyotype
- Techniques for obtaining a plant karyotype
- Chromosome mapping

Chapter 8: Sex chromosomes or gonosomes

- Sex determination in humans
- The human X chromosome
- The X chromosome (Lyon hypothesis)
- The human Y chromosome
- Different systems of sex chromosomes

Chapter 9: Genetic engineering techniques

- In situ hybridisation or molecular hybridisation
- Cloning

- Transgenesis

Tutorials

TD 1: Genetic material — mass, structure, stereochemistry

TD 2: Gene mutations

TD 3: Bacterial conjugation

TD 4: Genetic regulation .

TD 5: Monohybridism

TD 6: Di-hybridism

TD 7: Sex-linked inheritance

TD 8: Exceptions to Mendel’s laws

Practical Work:

PW 1: DNA extraction from fruit (e.g. banana or strawberry)

PW 2: Observation of mitosis in onion roots

PW 3: Study of trait inheritance in Drosophila (theoretical approach + simulation)

Semester: 03
Teaching Unit: Methodology
Subject: Biostatistics
VHS: h (C/T)
Credits: 2
Coefficient: 2
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training objectives

The objective of this course is to introduce students to statistical concepts and methods:

- Introduce students to the main statistical measures.
- Interpretation and use of data distributions.
- Introduce the concepts of probability, joint probability, conditional probability, and their relationships.
- Introduce the concept of observational study, sampling, and statistical inference from the sample.

At the end of the course, the student will be able to recognize the strengths and weaknesses of the statistical method. They will be able to carry out simple quantitative operations, such as interpreting an "abnormal" value or calculating probability. They will correctly interpret the concept of statistical tests.

Course content

Chapter 1: Introduction

1. Objectives
2. Relevance and fields of application of the statistical method
3. Concept of variability (definition of representative sample and population)
4. The scope of statistics
5. The statistical method
6. Some definitions

Chapter 2: Descriptive statistics for one variable

1. Basic concepts
2. Description, different types of variables: qualitative, quantitative
3. Frequency distributions
4. Graphical representations (construction and interpretation)
5. Measures of central tendency
6. Measures of dispersion

Chapter 3: Descriptive statistics for two variables

1. Introduction
2. Contingency tables
3. Frequency distributions
4. Graphical representation of bivariate statistics
5. Characteristics of a two-variable series
6. Concept of regression curve
7. Study of the relationship between two variables
8. Linear adjustment (regression line)
9. Principle of the least squares method
10. Correlation coefficient

Chapter 4: Probability calculus

1. Counting and combinatorial analysis
2. Basic notions of probability
3. Probability law on a finite set
4. Conditional probabilities
5. Bayes' theorem and formula
6. Law of total probability
7. Independent events
8. Theorem of compound probabilities
9. Theorem of total probabilities

Chapter 5: Random variables and main probability distributions

1. Probability distribution
2. Common probability laws
3. Bernoulli law, binomial law, Poisson law, normal law
4. Convergence in probability laws
5. Standard normal distribution
6. Use of statistical tables

Chapter 6: Sampling distributions

1. Sampling distribution of means
2. Sampling distribution of proportions
3. Sampling distribution of variances
4. Confidence interval of a mean
5. Confidence interval of the frequency of occurrence of a qualitative variable

Chapter 7: Estimation theory

1. Parameter estimation
2. Estimation of a mean
3. Estimation of a proportion
4. Estimation of a variance

Chapter 8: Statistical tests

1. Introduction
2. Definition of risks

3. Bilateral and unilateral tests
4. Formulation of test conclusions
5. Steps to perform a statistical test
6. Principle of statistical tests
7. Decision-making
8. Main statistical tests used:
    - 8.1. Comparison of an observed mean to a theoretical mean (large samples)
    - 8.2. Comparison of two observed means (large samples)
    - 8.3. Comparison of an observed proportion to a theoretical proportion
    - 8.4. Comparison of two observed proportions
    - 8.5. Comparison of an observed mean to a theoretical mean (small samples)
    - 8.6. Comparison of two observed means (small samples)
    - 8.7. Test for comparing two variances
    - 8.8. Chi-square tests
        - Test of goodness of fit
        - Test of independence
        - Test of homogeneity

Tutorials (TD)

- TD 1 – Presentation and description of a dataset
- TD 2 – Measures of central tendency and dispersion
- TD 3 – Statistical study with two variables
- TD 4 – Introduction to probability calculus
- TD 5 – Study of probability laws
- TD 6 – Introduction to statistical tests (mean test, proportion test, chi-square test)

Semester: 03
Teaching Unit: Methodology
Subject: Biophysics
VHS: h (C/T)
Credits: 2
Coefficient: 2
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objective:

This program aims to provide students with a structured theoretical foundation organized around four main areas. It first addresses the propagation of sound and ultrasonic waves, which are notably used in medical imaging, non-destructive testing of materials, and in biology to disturb certain cellular structures. It then covers electromagnetic radiation, emphasizing its characteristics and applications, such as detection, matter modification, and disease treatment. The third part is devoted to wave optics, focusing on interference and diffraction phenomena. Finally, cellular biophysics explores processes specific to living systems, such as membrane transport mechanisms and bioelectricity.

PART ONE: WAVES

Chapter I: Propagation Phenomena

Chapter II: Interference

Chapter III: Sound Waves

- Acoustic wave, pressure wave
- Acoustic power and acoustic impedance

Ultrasounds

- Introduction
- Production
- Applications

PART TWO: RADIATION

Chapter I: General Concepts of Radiation

Chapter II: Electromagnetic Radiation (EMR)

- Electromagnetic wave: definition, origin, and global spectrum
- Plane wave: definition, parameters, and properties
- Wave and particle aspects of EMR
- Energy of EMR

Chapter III: Detection of Radiation

Chapter IV: Examples of Applications — X-rays and Radioactive Radiation

A. X-radiation

- Definition
- Production
- Energy spectrum
- Properties and main applications

B. Radioactive Radiation

- Definition
- Radioactivity

Chapter V: Radiation–Matter Interaction — Radiation Protection

- EMR–matter interaction (Compton, photoelectric, and pair production effects)
- EMR–matter attenuation
- Radioactive particle–matter interaction
- Radiation protection — Dosimetry

PART THREE: WAVE OPTICS

- Light sources: incandescent lamp, spectral lamp, laser
- Wave nature of light
- Diffraction phenomenon
- Light interference
- Fraunhofer diffraction by a plane grating

PART FOUR: CELL BIOPHYSICS

- General concepts of electrolyte solutions: definition and properties
- Conductivity, resistivity, and resistance of electrolyte solutions
- Study of solid–liquid interfaces

- Study of liquid–gas interfaces
- Diffusion phenomena:
    - Diffusion in aqueous phase
    - Diffusion through biological and artificial membranes

Tutorials

TD1: Determination of the speed of ultrasound in air

TD2: Diffraction of light waves

TD3: Interference of light waves

TD4: Radioactivity and the law of radioactive decay

4th Semester

Semester: 04
Teaching Unit: Fundamental
Subject: Animal physiology
VHS: h (C/T/PW)
Credits: 6
Coefficient: 4
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

The general objective is to acquire comparative knowledge of the fundamental bases of major physiological functions and their regulation.

The specific objectives are the understanding of the respiratory, digestive, cardiovascular, muscular, excretory, nervous, and endocrine systems. For each system studied, students will be able to relate organ-level structure to function and environmental adaptation.

At the practical level, this course aims to develop technical and methodological skills in animal physiology. The planned dissections are intended not only to demonstrate the different organs and systems, but also to teach students how to observe, record, sketch, and describe biological material, thereby linking the concepts acquired during practical work to the theoretical topics covered in lectures.

Course Content:

CHAPTER I: The respiratory system

A. Structure of the respiratory system

B. Ventilatory mechanics (Inhalation and Exhalation)

C. Alveolar-capillary gas exchange

D. Transport of gases by the blood

E. Control and adaptation of pulmonary ventilation

F. Different types of respiration

- Influence of environmental characteristics
- Cutaneous respiration (aquatic environment)
- Gill respiration (aquatic environment)
- Tracheal respiration (insects)

- Special case of cetaceans

G. Regulation of respiration

CHAPTER II: The cardiovascular system

A. The heart

1. Morphology
2. Cardiac activity
3. Cardiac electrophysiology: ECG
4. Regulation of cardiac activity

B. Circulation in blood vessels

1. General characteristics
2. Vasomotricity
3. Arterial pressure and its regulation
4. Capillary circulation
5. Venous circulation
6. Pulmonary circulation

1. Blood components

- Plasma
- Red blood cells
- White blood cells
- Platelets

2. Functions of blood

- Oxygen transport
- Carbon dioxide transport
- Transport of other substances
- Hemostasis

3. Blood groups

CHAPTER III: RENAL PHYSIOLOGY

A. Morphological data

1. General structure of the kidney

2. Structure of the nephron
3. Renal circulation

B. Urine formation

1. Glomerular filtration
2. Tubular reabsorption
3. Tubular secretion

C. Renal function and homeostasis

1. Control of acid-base balance
2. Control of hydro-electrolytic balance

D. Types of excretion according to environment

- Metanephridia of annelids
- Green gland of crayfish
- Malpighian tubules of insects
- Fish gills

2. Other excretory organs

- Sweat glands
- Gallbladder

CHAPTER IV: THE DIGESTIVE SYSTEM

1. Digestive organs of vertebrates (monogastric, polygastric animals, and birds)
2. Physiology of digestion
    - Mechanical processes: mastication, swallowing, peristalsis
    - Chemical processes: gastric and intestinal juices
3. Structure of less evolved digestive systems
    - Annelids
    - Insects
4. Main types of feeding behavior
    - Microphagy
    - Osmotrophy
    - Phytophagy
    - Predation

CHAPTER V: THERMOREGULATION

Definitions:

- Endothermy
- Ectothermy

A. General characteristics of endothermic animals

1. Average internal temperature values
2. Thermal core and shell

B. Heat exchange between the organism and the environment

3. Evaporation
4. Radiation
5. Conduction and convection

C. Regulation of core temperature

6. Central and peripheral thermoreceptors
7. Thermoregulatory mechanisms
    a. Protection against cold
    b. Protection against heat
8. Limits of homeothermy

D. Hibernation

9. Energy requirements of hibernating animals
10. Physiological adaptations
    a. Entry into lethargy
    b. Actual hibernation
    c. Emergence from hibernation

CHAPTER VI: PHYSIOLOGY OF THE INTERNAL ENVIRONMENT

A. Fluid compartments of the organism

1. Distribution and volume
2. Composition
3. Fluid exchanges between compartments

B. Regulation of hydro-electrolytic balance

4. Na^+ and K^+ exchanges

5. Water balance

C. Regulation of plasma pH

6. Plasma buffer system
7. Role of the kidney
8. Role of the respiratory system

CHAPTER VII: THE NERVOUS SYSTEM

1. General organization

- Central nervous system: brain and spinal cord
- Peripheral nervous system: somatic and autonomic
- Structure and role of the neuron

2. Physiology of the nervous system

- Excitability
- Conductibility
- Synaptic transmission

3. Functions of the nervous system

A. NEUROMUSCULAR PHYSIOLOGY

Introduction:

Definition of the nervous system and its different components

I. PHYSIOLOGY OF THE NEURON

A. Structure of the neuron

B. Membrane potential

1. Resting potential
2. Action potential (A.P.)

C. Neuronal excitability

1. Excitation threshold
2. All-or-none law
3. Refractory period law

D. Neuronal conductibility

1. Mechanism of action potential propagation

2. Conduction velocity of the nerve impulse
3. Direction of nerve impulse propagation

II. SYNAPTIC TRANSMISSION

A. The synapse

1. Definition and classification
2. Morphology

B. Mechanisms of neurotransmission

1. Definition of neurotransmission
2. Neurotransmitter release
3. Postsynaptic potentials: EPSP and IPSP
4. Fundamental properties of neurotransmission

C. Special types of synapses

1. Neuromuscular synapse (motor end plate)
2. Synapse of sympathetic ganglia

D. Synapse of the central nervous system

III. MUSCULAR ACTIVITY

A. Organization of striated, smooth, and cardiac muscle

B. Properties of striated muscle

C. Excitation-contraction coupling

D. Types of muscular contractions

E. Factors influencing contraction

F. Excitation-contraction coupling

1. Motor end plate
2. Biochemical modifications

G. Heat production and energetics of contraction

1. Thermal and metabolic aspects
2. Muscle fatigue
3. Rigor mortis

CHAPTER VIII: THE ENDOCRINE SYSTEM

A. General concepts

1. Review of hormonal mechanisms
2. Role of hormones in homeostasis

B. Study of some major endocrine functions

1. Hypothalamic-pituitary axis
2. Thyroid gland
3. Adrenal glands
4. Endocrine pancreas
5. Hormones involved in growth

Practical work

PW1: Dissection of a mammal (mouse)

PW2: Dissection of a fish

PW3: Dissection of an amphibian

PW4: Comparative anatomy of nervous systems — dissection of a sheep brain

PW5: Study of hemolysis

Semester: 04
Teaching Unit: Fundamental
Subject: Immunology
VHS: h (C/T/PW)
Credits: 6
Coefficient: 4
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

- This immunology course aims to introduce students to the fundamental mechanisms of the immune response.
- It builds on acquired knowledge in Mendelian and molecular genetics, cell biology, biochemistry, microbiology, and histology.
- The main objective is to provide a comprehensive understanding of how the immune system functions, in both its normal and pathological aspects.
- Students will discover the various cellular and molecular elements involved in innate and adaptive immune responses, as well as the mechanisms that can lead to failures (immunodeficiencies) or exaggerated reactions (hypersensitivities, autoimmunity).
- This course completes the students' basic training by providing them with essential knowledge for understanding host-pathogen interactions and therapeutic strategies in immunology.

Course Content:

Chapter 1: History and fundamental concepts
- Origins of immunology
- Evolution of concepts: self and non-self

Chapter 2: Components of the immune system (Immune cells and lymphoid tissues)
A. Immune cells
- T and B lymphocytes and antigen-presenting cells (APCs)
- Monocytes/macrophages, granulocytes, natural killer (NK) cells

B. Lymphoid tissues
- Primary: bone marrow, thymus, bursa of Fabricius (in birds)
- Secondary: spleen, lymph nodes
- Tertiary: MALT (mucosa-associated lymphoid tissue), intraepithelial lymphocytes

Chapter 3: Antigens and Immunogens

1. Characteristics of antigens
2. Factors influencing immunogenicity
3. Major histocompatibility complex (MHC/HLA)
4. Cellular antigen receptors

Chapter 4: Innate Immunity

1. Epithelial barriers
2. Phagocytosis
3. Inflammation
4. Natural killer (NK) cells
5. Complement system

Chapter 5: Cellular Immunity

- Role of T lymphocytes
- Activation, differentiation, and cytotoxic effects

Chapter 6: Humoral Immunity

- Structure and classes of immunoglobulins
- Mechanisms of the humoral response
- Stages of the adaptive immune response

Chapter 7: The Immune System in Action

- Cooperation between innate and adaptive immunity
- Immune memory

Chapter 8: Immune Tolerance

- Recognition of self
- Mechanisms of central and peripheral tolerance

Chapter 9: Immune System Dysfunctions

- Hypersensitivity (types I to IV)
- Autoimmune diseases
- Immunodeficiencies (congenital and acquired)

Chapter 10: Immunological Therapies

A. Vaccination and serotherapy

B. Immunosuppression in organ transplantation

Tutorials (TD):

- **TD 1:** Antigens
- **TD 2:** Immunoglobulins
- **TD 3:** Humoral and cellular immune responses
- **TD 4:** The Major Histocompatibility Complex (MHC)
- **TD 5:** Functioning of the complement system

Semester: 04
Teaching Unit: Fundamental
Subject: Microbiology
VHS: h (C/T/PW)
Credits: 7
Coefficient: 4
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

Microorganisms are invisible to the naked eye, yet they are essential components of every ecosystem. The objective of this course is to acquire knowledge in general microbiology, from both theoretical and methodological perspectives. The teaching will cover applications in three main sectors:

- Health – Food
- Environment
- Industry

Course Content:

Introduction

Chapter I: Structure of the prokaryotic cell

1.Introductino

2. General characteristics of prokaryotic cell

3. General characteristics of Eukaryotic cell

4. Comparing prokaryotes and eukaryotes

4.1 Key similarities between prokaryotes and eukaryotes

4.2 The difference between Prokaryotic and Eukaryotic cell

5. Prokaryotic cell organization

5.1. Plasma membrane

5.2. Cytoplasm

5.3. Cell wall

Chapter II: Diversity and classification of microorganisms

1.Introduction

2.The Different Classifications of the Living organism Through Time

3. Microbial Groups

4.Taxonomic ranks

5. Binomial Nomenclature

6.The main characteristics used in taxonomy

- 6.1. Classical characteristics
  - 6.1.1. Morphological characteristics
    - 6.1.1.1. Cell size and shape
    - 6.1.1.2. Colonial morphology
    - 6.1.1.3. Flagella and motility
    - 6.1.1.4. Cell wall composition
  - 6.1.2. Physiological and Metabolic characteristics
    - 6.1.2.1. The Preference for Temperature
    - 6.1.2.2. pH
    - 6.1.2.3. Oxygen Requirement
    - 6.1.2.4. Respiratory and Fermentation Pathways
  - 6.1.3. Ecological characteristics
  - 6.1.4. Genetic characteristics
- 6.2. Molecular characteristics
  - 6.2.1. Nucleic acid base composition
  - 6.2.2. Nucleic Acid Hybridization
  - 6.2.3. Nucleic Acid Sequences
  - 6.2.4. Comparison of proteins
  - 6.2.5. Genomic Fingerprinting Techniques

7.Classification systems

- 7.1. Phenetic classification
- 7.2. Numerical taxonomy
- 7.3. Phylogenic classification

8. Type of Microorganisms

- 8.1. Bacteria
- 8.2. Algae

8.3. Archeae

8.4. Fungi

Chapter 3: Nutrition and bacterial growth

1. Nutrient requirements
    1.1. Macroelements
    1.2. Microelements
2. Nutrient requirements Carbon, hydrogen, oxygen and electron requirements
3. Nutrient Uptake
    3.1. Passive diffusion
    3.2. Facilitated diffusion
    3.3. Active Transportation
    3.4. Group Translocation
4. Culture media
    4.1. Type of Culture Media
        4.1.1. Classification based on Physical State
            4.1.1.1. Liquid media
            4.1.1.2. Solid media
            4.1.1.3. Semi solid media
        4.1.2. Classification based on functional use or application
            4.1.2.1. Basal media
            4.1.2.2. Enriched media
            4.1.2.3. Selective media
            4.1.2.4. Indicator or differential media
            4.1.2.5. Transport media
        4.1.3. Classification based on nutritional component
            4.1.3.1. Simple Media
            4.1.3.2. Complex Media
            4.1.3.3. Synthetic Media
5. The Cell Cycle
    5.1. Phases of the Bacterial Cell Cycle
    5.1. Phases of the Bacterial Cell Cycle

5.2. Important Steps in the Bacterial Cell Cycle

5.3. Control

5.4. How it is different from the eukaryotic cell cycle

6. Bacterial Growth Curve

6.1. Lag phase

6.2. Log phase or exponential phase

6.3. Stationary phase

6.4. Decline phase

7. Bacterial Metabolism

7.1. Respiration

7.2. Enzymes and regulation

7.3. Energy and biosynthesis

Chapter IV: Control of micro-organisms by physical and chemical agents

1. Introduction to the control of microorganisms

2.Physical agents

2.1. Temperature

2.1.1. High temperature

2.1.1.1. Moist heat

2.1.1.2. Dry heat

2.1.1.3. Pasteurization

2.1.2. Low temperature

2.2. Desiccation

2.3. Osmotic Pressure

3. Chemical agents

3.1. Disinfectants

3.2. Antibiotics

3.2.1. Generalities

3.2.2. Mechanisms of Action of Antimicrobial Drugs

3.3.3. Mechanism of antibiotic action

3.3.4. Resistance to Antimicrobial Drugs

3.3.5. Mechanisms of Antibiotic Resistance

Chapter V: Food and industrial microbiology

1.Introduction

2. Sources of Microbes in Food

    2.1. Raw Ingredients

    2.2. Environmental Contamination

    2.3. Processing and Fermentation

    2.4. Storage and Handling

    2.5. Packaging

    2.6. Animal Products

    2.7. Cross-contamination

    2.8. Spoilage Microorganisms

3. Microbes and Food Spoilage

4. Fermentation

    4.1. Types of Fermentation

    4.2. Microorganisms Involved in Fermentation

    4.3. Fermentation application

5. Biodegradation and Bioremediation

    5.1. Bioremediation

    5.2. Biodegradation

Chapter VI: General virology

1. Introduction

2. Basic concepts of viruses

    2.1. Definition

    2.2. Structure of viruses

        2.2.1. Nucleic Acid

        2.2.2. Capsid

        2.2.3. Envelope

        2.2.4. Spikes (Glycoproteins)

        2.2.5. Matrix Proteins

        2.2.6. Viral Enzymes

Semester: 04
Teaching Unit: Fundamental
Subject: Botany
VHS: h (C/T/PW)
Credits: 6
Coefficient: 4
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

The objective is to provide theoretical and practical bases allowing the acquisition of knowledge and concepts in the classification and systematics of the major groups of the plant kingdom as well as the classification criteria.

General introduction to botany: Definition, concepts and notions in the classification and systematics of the major groups of the plant kingdom, and classification criteria.

CHAPTER 1: ALGAE

1.1. Morphology and evolution of thalli

1.2. Cytological characteristics

- Cell wall
- Structure and evolution of plastids

1.3. Reproduction

- Concept of gamy
- Developmental cycles (mono-, di-, and trigenetic)

1.4. Systematics and characteristics of the main groups:

a) Prokaryotic algae: Cyanoschizophytes (cyanobacteria)

b) Eukaryotic algae: Phycophytes

c) Rhodophycophytes

d) Chromophycophytes (Pyrrophytes, Chrysophytes, Algenophytes, Phaeophytes)

e) Chlorophycophytes

f) Charophycophytes

CHAPTER 2: FUNGI AND LICHENS

2.1. Problems related to fungal classification

2.2. Structure of thalli

- Mycelia
- Stroma
- Sclerotia, etc.

2.3. Reproduction

- Asexual reproduction (arthrospores, chlamydospores, conidia)
- Sexual reproduction (types of plasmogamy)
- Myxomycetes
- Phycomycetes
- Trichomycetes
- Basidiomycetes
- Zygomycetes

2.4. A particular algae-fungus association: lichens

- Structure
- Reproduction
- Classification

CHAPTER 3: BRYOPHYTES

- Comparative study of morphology and reproduction in the different classes
- Mosses (capsule structure in different orders)
- Liverworts (evolution and regression of Marchantiales)
- Hornworts

CHAPTER 4: PTERIDOPHYTES

4.1. General concepts on the particular morphological characteristics of pteridophytes

4.2. Evolutionary importance of reproduction

- Concept of endoprothallia
- Heterospory
- Reduction of the gametophytic phase

4.3. Systematics

- Psilophytinae
- Lycopodinae
- Equisetinae
- Filicinae

CHAPTER 5: PHANEROGAMS

5.1. Prephanerogams

5.1.1. Evolutionary importance of prephanerogams

5.1.2. Reproduction

- Concept of the ovule

5.1.3. Systematics

- Pteridosperms (Caytoniales, Cycadales)
- Cordaites (Cordaitales, Ginkgoales)

5.2. Gymnosperms

5.2.1. Morphological, anatomical, and chemotaxonomic characteristics

5.2.2. Reproduction

- Concepts of flower, inflorescence, and seed

5.2.3. Systematics

- Pinales
- Araucariales
- Podocarpales
- Cupressales
- Taxales

5.2.4. Transitional group: Chlamydosperms

- Ephedrales
- Welwitschiales
- Gnetales

5.3. Angiosperms

5.3.1. Morphological, anatomical, and chemotaxonomic characteristics

5.3.2. Reproduction

5.3.3. Systematics

Tutorials

TD1: Algae (Cytological characteristics (cell wall, plastids), reproduction: gamy, mono-, di-, and trigenetic cycles, systematics of the main groups (Cyanos, Phycophytes, etc.)).

TD2: Fungi and Lichens (Structure, reproduction, and classification).

TD3: Bryophytes (Comparative study of morphology and reproduction of mosses, liverworts, and hornworts).

TD4: Pteridophytes (Particular morphological and systematic characteristics).

TD5: Gymnosperms (Reproduction and systematics of the groups (Pinales, Chlamydosperms, etc.)).

TD6: Angiosperms (Reproduction and systematics of angiosperms).

Practical work

PW1: Algae

PW2: Fungi

PW3: Lichens

PW4: Bryophytes

PW5: Pteridophytes

PW6: Gymnosperms

Semester: 04
Teaching Unit: Methodology
Subject: Biochemistry 2
VHS: h (C/T/PW)
Credits: 7
Coefficient: 4
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

Biochemistry lies at the interface between biology and chemistry. It concerns the study of the structure and function of biomolecules and multimolecular complexes. This course will enable students to acquire several competencies:

- Understand how a living organism is organized at the molecular level using appropriate terminology.
- Understand the regulatory mechanisms of physiological and pathophysiological processes through knowledge of the structure of macromolecules and their interactions.
- Identify appropriate experimental approaches for the study of macromolecules through mastery of classical experimental methods (spectrophotometric assays, electrophoresis), thereby meeting the requirements of research and development in life and natural sciences in the fields of biotechnology, agronomy, environmental biology, marine biology, etc.

Course Content:

CHAPTER 1: Carbohydrate Metabolism

I. Carbohydrate Catabolism

- Glycolytic pathway
- Fate of NADH, H^+, and pyruvic acid formed during glycolysis
- Krebs cycle
- Pentose phosphate pathway

II. Energy balance of carbohydrate catabolism

III. Carbohydrate storage and glycogen metabolism

IV. Carbohydrate anabolism: gluconeogenesis

CHAPTER 2: Lipid Metabolism

I. Lipid Catabolism

- Lipolysis
- Regulation of lipolysis
- β-oxidation

II. Lipid Biosynthesis

- Biosynthesis of fatty acids
- Biosynthesis of glycerol phosphate

CHAPTER 3: Protein Metabolism

I. Digestion and absorption of proteins

II. Protein Catabolism

- Deamination of amino acids
- Fate of ammonia: urea cycle

III. Biosynthesis of amino acids

IV. Regulation

Tutorials

TD1: Exploring proteins and enzymatic activity (Classify amino acids, analyze peptide structure, understand the role of enzymes and their regulation).

TD2: Visualizing and connecting metabolic pathways (Map metabolic pathways of carbohydrates, lipids, and proteins).

TD3: Analyzing energy balances and metabolic interconnections.

Semester: 04
Teaching Unit: Methodology
Subject: Ecology
VHS: h (C/T)
Credits: 4
Coefficient: 2
Evaluation method: Continuous assessment: 40% Exam: 60 %.

Training Objectives:

This course is structured with the skill approach system. The skills referred to in this course are as follows:

- Know and identify the specific terminology of the module in question, such as the notion of ecosystem, biocenoses, biotope, ecological factors, the notion of living communities: phytocenoses, zocenoses, biomes.
- Identify the structure and functioning of ecosystems for understanding environments and living communities.
- Disassemble the ecological, abiotic, and biotic factors, as well as the classification of the different possible interactions between living beings, between them, and between their environments.
- Explain the notion of chain and trophic network to understand the organization of food relationships in an ecosystem.
- Being able to contribute to decision-makers to properly manage natural resources, rationally and sustainably, and set up ecologically correct practices (example: sustainable development).

Course Content:

Chapter 1: General Concepts

1.1. Definition

1.2. Fields of application

1.3. Concept of an ecological system: Ecosystem

Chapter 2: The Environment and Its Components

2.1. Concept of ecological niche

2.2. Concept of habitat

2.3. Concept of environmental factors

2.4. Interaction between the environment and living organisms

2.4.1. Law of tolerance (tolerance range)

2.4.2. Law of the minimum

2.4.3. Limiting factor

Chapter 3: Abiotic Factors

3.1. Climatic factors

3.1.1. Definition of climate

3.1.2. Main climatic factors

a) Temperature
b) Humidity and rainfall
c) Light and sunlight exposure
d) Wind
e) Snow

3.2. Edaphic factors

3.2.1. Definition of soil

3.2.2. Edaphic factors

a) Soil texture
b) Soil structure
c) Soil water
d) Soil pH
e) Chemical composition

Chapter 4: Biotic Factors

4.1. Homotypic interactions

4.1.1. Group effect

4.1.2. Mass effect

4.1.3. Intraspecific competition

4.2. Heterotypic interactions

4.2.1. Neutralism

4.2.2. Interspecific competition

4.2.3. Predation

4.2.4. Parasitism

4.2.5. Commensalism

4.2.6. Mutualism

4.2.7. Amensalism

Chapter 5: Structure and Functioning of Ecosystems

5.1. The biosphere and its components

5.2. Organization of the biosphere

5.3. Food chain

5.3.1. Definition

a) Producers
b) Consumers
c) Detritivorous consumers
d) Nitrogen-fixing organisms

5.3.2. Different types of food chains

5.3.3. Graphical representation of food chains

5.3.4. Food web

5.4. Energy transfer and efficiencies

5.4.1. Definition

5.4.2. Energy transfer

5.4.3. Efficiencies

5.4.4. Ecosystem stability

5.5. Biogeochemical cycles

5.5.1. Water cycle

5.5.2. Carbon cycle

5.5.3. Phosphorus cycle

5.5.4. Nitrogen cycle

Tutorials

TD1: Terrestrial and aquatic ecosystems: terrestrial biomes, freshwater ecosystems, and marine ecosystems

TD2: Abiotic factors: climatic and edaphic factors

TD3: Biotic factors: interspecific relationships

TD4: Food chains; ecosystem structure; feeding factors

TD5: Ecological pyramids

TD6: Biogeochemical cycles: water cycle, carbon cycle, and nitrogen cycle