<table>
<tr><td>Course title</td><td colspan="5">Molecules, cells and tissues & Organs I</td></tr>
<tr><td>Course code</td><td colspan="5">MD-101</td></tr>
<tr><td>Course type</td><td colspan="5">Required</td></tr>
<tr><td>Level</td><td colspan="5">1st cycle: undergraduate</td></tr>
<tr><td>Year / Semester</td><td colspan="5">Year 1 / Semester 1 (Fall)</td></tr>
<tr><td>Teacher’s name</td><td colspan="5">Stella Loizou / Christiana Charalambous</td></tr>
<tr><td rowspan="2">ECTS</td><td rowspan="2">15</td><td>Large Group Learning per Week</td><td>Tutorials per Week</td><td>Small group work per Week</td><td>Laboratories</td></tr>
<tr><td>6.5</td><td>3</td><td>3</td><td>6</td></tr>
<tr><td>Course purpose and objectives</td><td colspan="5">The main objectives of the course are to:
1. Describe the evolution of molecular, cellular, tissue, and organ knowledge and its impact on medical advancements.
2. Recognize the hierarchical organization of living organisms.
3. Identify the characteristics that define living organisms.
4. Categorize major taxonomic groups and understand classification principles.
5. Discuss the principles of evolution and provide examples of adaptation.
6. Explain the use and function of different types of microscopes in cell study.
7. Compare prokaryotic and eukaryotic cell structures and functions.
8. Describe the structural characteristics of fungi, protists, viruses, phages, prions, and viroids.
9. Discuss the role of microorganisms and viruses in human diseases.
10. Explain the structure and functions of key biomolecules such as carbohydrates, lipids, and proteins.
11. Discuss the significance of pH and buffer systems in biological processes.
12. Analyse the role of thermodynamics and kinetics in enzymatic reactions.
13. Define enzyme inhibitors and their effects on enzymatic activity.
14. Describe the properties of allosteric enzymes and their regulation.
15. Explain ligand binding, including cooperativity, in proteins.
16. Discuss antibody structure and function and their role in immune responses.
17. Relate protein structure to function in examples like myoglobin and haemoglobin.
18. Explain the organization and function of DNA, including replication, transcription, and translation processes.
19. Discuss methods for sequencing DNA and measuring gene expression in clinical applications.</td></tr>
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	20. Describe the stages and regulation of the cell cycle and implications for cancer. 21. Explain genetic inheritance patterns and the impacts of genetic diversity. 22. Discuss roles of clinical geneticists and importance of genetic testing. 23. Analyse the relationship between genetic mutations and diseases. 24. Explain how cellular respiration produces ATP and the metabolic pathways involved. 25. Describe energy dynamics within the human body and the regulation of metabolism.
Learning outcomes	**<u>Theme 1: The first cells</u>** 1. Explain how the understanding of molecules, cells, tissues, and organs has evolved and contributed to advancements in medical diagnosis and treatment. 2. Describe the hierarchical structure of living organisms. 3. Explain the fundamental characteristics that define life. 4. Recognize and categorize the major taxonomic groups, including domains and kingdoms, and understand the basis for classification. 5. Discuss the principles of evolution and natural selection, and provide examples of evolutionary processes and adaptations. **<u>Theme 2: Cell Structure and diversity</u>** 6. Describe the applications of various microscopes, including light and electron microscopes, in studying structure. 7. Describe, compare and contrast the cellular structure and function of prokaryotic and eukaryotic cells. 8. Describe the structure of fungi, protists, viruses, phages, prions and viroids. 9. Briefly discuss the role of microorganisms and viruses in human disease. **<u>Theme 3: Molecules and compounds crucial to life</u>** 10. Describe the structural characteristics and functions of key carbohydrates and lipids in biological systems. 11. Explain the structure of proteins and the fundamental properties of amino acids that comprise them. 12. Explain the concept of pH and its critical role in protein structure and function. 13. Discuss the definitions of strong and weak acids and bases, including their roles in biological systems. 14. Explain the equilibria of weak acids and bases and their importance in buffering systems that regulate blood pH. 15. Explain the concept of enthalpy and its significance in biochemical reactions and metabolic processes within the human body.

16. Analyse the roles of exothermic and endothermic reactions in physiological processes.
17. Briefly outline the pentose phosphate pathway and its role in the redox balance in cells.
18. Explain Gibbs free energy and its application in predicting the spontaneity and direction of metabolic reactions.
19. Identify and describe the types and chemical basis of intermolecular forces and their roles in maintaining the structure and function of biological macromolecules.
20. Describe the components and structural organization of nucleotides and the differences between RNA and DNA.
21. Briefly describe the different types of RNA molecules.

Theme 4: Protein form and function

22. Briefly explain the principles behind protein folding and how misfolding is implicated in diseases such as Alzheimer and Parkinson diseases.
23. Explain basic principles of thermodynamics and kinetics as they apply to enzymatic reactions in cells.
24. Define and discuss examples of reversible and irreversible enzyme inhibitors.
25. Describe Michaelis-Menten kinetics and how they can describe the effects of reversible inhibition.
26. Describe allosteric enzymes and the effects of allosteric effectors.
27. Define the basic principles behind ligand binding to proteins, including cooperativity.
28. Describe the structure of the antibody molecule and effector functions of different classes of antibodies.
29. Explain how molecular interactions affect body function, using the interactions between antibodies, immunoglobulins and antigens as an example to illustrate how they facilitate the immune response.
30. Explain how protein structure can affect protein function, using myoglobin and haemoglobin as examples.
31. Describe the factors that affect the oxygen binding properties of haemoglobin.
32. Discuss the functional significance of structural differences in embryonic, foetal and adult proteins, using haemoglobin as an example.

Theme 5: Genes, genomes and gene expression

33. Describe the organization of DNA in cells.
34. Describe the structure of chromosomes and compare autosomal and sex chromosomes.
35. Define epigenetic changes and their effect on DNA structure and function.

36. Describe the process of DNA replication, its fidelity and regulation.
37. Describe the process of transcription, its regulation and RNA processing in eukaryotic cells and briefly compare it to prokaryotic cells.
38. Describe the process of translation and its regulation.
39. Discuss methods in determining DNA sequences such as Sanger sequencing and high throughput sequencing and their highlight their importance in a clinical setting.
40. Discuss methods in detecting and quantifying gene express at the mRNA and protein levels and emphasize their medical applications.

Theme 6: The life cycle of cells

41. Describe the different stages of the cell cycle.
42. Describe the regulation of the cell cycle, through the checkpoints and how dysregulation can result in benign and malignant tumours.
43. Define oncogenes and tumour suppressor genes, using key examples such as p53, Rb and Ras.
44. Outline the process of meiosis and compare with mitosis.
45. Discuss processes that contribute to genetic variation such as crossing over and independent assortment.
46. Define and compare major cellular process that result in cell death.
47. Briefly describe major apoptotic pathways and their regulation.
48. Discuss the therapeutic applications of inducers of apoptosis and cell cycle inhibitors.

Theme 7: Genetic inheritance and genetic diversity

49. Describe the role of the clinical geneticist in a modern healthcare system.
50. Explain what karyotypes and pedigrees are and how they can be used to study genetic inheritance.
51. Explain the foundational principles of Mendelian inheritance to include Mendel's laws of segregation and independent assortment.
52. Compare and contrast autosomal, recessive and X-linked inheritance.
53. Briefly discuss the role of genetic testing for human genetic disorders.
54. Discuss the role of gene linkage in inheritance.
55. Describe the genetic basis of chromosomal abnormalities and their clinical consequences.
56. Explain the application of probability laws in genetic inheritance and apply them to calculate probabilities of different genetic outcomes, including genotype/phenotype frequencies.
57. Analyse pedigrees to decipher the various inheritance patterns.

	58. Define the terms penetrance, expressivity and genetic heterogeneity and provide examples. 59. Describe genotype/ phenotype correlation and provide examples. 60. Explain how mutations in genes encoding receptors and signalling pathway components cause disease and illustrate with relevant examples. 61. Describe the use of the Hardy-Weinberg law to estimate the carrier frequency of autosomal recessive disorders. 62. Explain the mode of inheritance of MHC. 63. Outline the different mechanisms of MHC variation in a population. 64. Explain the significance of MHC variability within a population. **<u>Theme 8: Energy flow</u>** 65. Describe the chemical principles applied to cellular respiration and compare and contrast aerobic and anaerobic respiration in cells. 66. Discuss the role of the production and hydrolysis of ATP in cellular respiration. 67. Understand the relationship between energy, work, and power, and explain their relevance in the human body. Discuss how energy is used in metabolic processes, the body's energy consumption, and how exercise impacts energy expenditure. 68. Outline the major pathways of metabolism of carbohydrates, proteins, lipids, nucleotides and ketone bodies, briefly discuss how they are regulated and provide examples of the consequences of dysregulation.		
Prerequisites	None	**Required**	None
Course content	**Themes:** • The first cells • Cell Structure and diversity • Molecules and compounds crucial to life • Protein form and function • Genes, genomes and gene expression • The life cycle of cells • Genetic inheritance and genetic diversity • Energy flow		
Teaching methodology	Lectures Tutorials Flipped learning Directed self-learning Group Work		

Bibliography

Required Textbooks/Reading:

Authors	Title	Edition	Publisher	Year	ISBN
N.A. Campbell, L.A. Urry, M.L. Cain, S.A. Wasserman, P.V. Minorsky, J.B. Reece	Biology: A Global Approach	12th Edition	Pearson	2020	9781292341637
David L. Nelson, Michael M. Cox	Lehninger Principles of Biochemistry	8th Edition (International)	W. H. Freeman and Company	2021	9781319381493
Ronald Cohn, Stephen Scherer, Ada Hamosh	Thompson & Thompson Genetics and Genomics in Medicine	9th Edition	Elsevier	2023	9780323547628

Recommended Textbooks/Reading:

Authors	Title	Edition	Publisher	Year	ISBN
Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter	Molecular Biology of the Cell	7th Edition	Norton & Company	2022	9780393884852
John McMurry, David S. Ballantine, Carl A. Hoeger, Virginia E. Peterson	Fundamentals of General, Organic, and Biological Chemistry	8th Edition	Pearson Education	2018	9780134015187

Assessment

- Midterm exam (30%)
- Final exam (60%)
- Coursework (10%)

Language

English