Course Code	Course Title	ECTS Credits
MED-209	Biochemistry II	6
School	**Semester**	**Prerequisites**
Medical School	Spring (Semester 4)	Completion of Semester 3
Type of Course	**Field**	**Language of Instruction**
Required	Medicine	English
Level of Course	**Year of Study**	**Course Lead:**
Undergraduate	2nd	Dr Chloe Antoniou
Mode of Delivery	**Work Placement**	**Co-requisites**
Face-to-face	N/A	

Objectives of the Course:

The aim of this course is to provide students with an in-depth understanding of fundamental principles biochemistry, cell and molecular biology topics. This course is the second course of a series of two biochemistry courses and starts of with section on metabolism and nutrition which serves as a continuation of the first course. The second part of the course focused on fundamental topics of cell and molecular biology.The specific objectives of the course will be accomplished through lectures, laboratory sessions and tutorials in order for students to not only understand the material, but also develop skills in order to apply their knowledge.

Learning Outcomes:

The following list provides the learning objectives that will be covered in the lectures, laboratory practicals and tutorials of each week:

Week 1

Lobs covered during lectures:

1. Describe the reactions of the pentose phosphate pathway and its regulation.
2. Discuss disorders related to the pentose phosphate pathway such as glucose 6-phosphate dehydrogenase deficiency.
3. Discuss the metabolism of purines and pyrimidines.

Lobs covered during tutorial:

4. Discuss the overall aims of the lab project.
5. Describe and explain the experiments used in the lab project.
6. Discuss how to interpret potential results.

Week 2

Lobs covered during lectures:

7. Describe the role of chemotherapy drugs in nucleotide metabolism.
8. Discuss disorders of nucleotide metabolism.
9. Define basic concepts in nutrition e.g. essential nutrients, balanced diet, recommended daily allowance, body mass index etc.

10. Describe the functions of vitamins A, C, D, E and K.
11. Describe the functions of the B vitamins and discuss examples of metabolic reactions that require them.

Lobs covered during laboratory practical:

12. Explain the principles behind the process of DNA extraction.
13. Explain how to determine DNA concentrations from absorbance measurements.
14. Perform DNA isolation from saliva and calculate the concentrations of the resulting DNA sample.

Week 3

Lobs covered during lectures:

15. Discuss vitamin deficiencies and toxicities.
16. Define major and trace minerals and discuss the effects of their deficiencies and toxicities.
17. Describe the nutritional requirements at each stage of the life span (pregnancy, first year of life, childhood and adolescence and age 65+).
18. Discuss the metabolism of phospholipids and its regulation.
19. Discuss the metabolism of sphingolipids and its regulation.
20. Discuss the metabolism of eicosanoids and its regulation.

Tutorial:

USMLE problem solving

Week 4

Lobs covered during lectures:

21. Discuss the metabolism of steroids (hormones, cholesterol, vitamin D etc.) and their regulation.
22. Discuss the structure, function and metabolism of creatine.
23. Discuss the structure, function and metabolism of glutathione.
24. Discuss the structure, function and metabolism of S-adenosylmethionine.
25. Discuss the structure, function and metabolism of GABA.
26. Discuss the structure, function and metabolism of heme.
27. Discuss the structure, function and metabolism of nitric oxide.
28. Discuss the structure, function and metabolism of nitric oxide.
29. Discuss the structure, function and metabolism of histamine.
30. Discuss the structure, function and metabolism of melanin.
31. Discuss the structure, function and metabolism of catecholamins.
32. Discuss the structure, function and metabolism of peptide hormones such as insulin.

Lobs covered during laboratory practical:

33. Perform a PCR experiment with the isolated DNA.

Week 5

Lobs covered during lectures:

34. Discuss the structure, function and metabolism of thyroid hormones.
35. Discuss the structure, function and metabolism of hormones of the renin-angiotensin system.
36. Describe the metabolic reactions carried out by the lysosome and their related disorders
37. Describe the reactions carried out by peroxisomes and their related disorders.

Tutorial:

Revision

Week 6

Lobs covered during lectures:

38. Revise the process of replication.
39. Explain the different types of recombination and provide examples of each.
40. Discuss the appropriate controls for the experiment and how to interpret different potential results.
41. Perform a restriction digestion of the PCR product of the previous step.

MIDTERM EXAM

Week 7

Lobs covered during lectures:

42. Revise transcription and translation.
43. Explain how to experimentally determine gene expression at the mRNA level using techniques such as quantitative reverse transcription PCR.
44. Explain how to experimentally determine gene expression at the protein level using techniques such as Western blots and ELISAS.
45. Explain how to experimentally determine gene expression at the protein level in vivo using fluorescence microscopy.
46. Describe the co-translational and post-translational protein sorting pathways.
47. Explain how proteins are targeted to different cellular locations.
48. Discuss disorders that result from improper protein targeting e.g. cystic fibrosis.

Lobs covered during tutorial:

49. Outline methods used in determining DNA sequences using dideoxy sequencing and RFLP analysis.
50. Outline methods in high throughput sequencing and their applications.
51. Describe applications of DNA sequencing by solving forensics problems such as sample identification or paternity.
52. Discuss the applications of recombinant protein technologies in medicine.

53. Discuss how bacteria, yeast and other organisms can be used in recombinant technologies.
54. Discuss techniques used in recombinant protein technologies such as plasmid construction such as ligations and recombination.
55. Explain commonly used techniques such as the different types of microarrays, Southern blotting, Northern blotting etc.

Week 8

Lobs covered during lectures:

56. Explain O- and N-linked glycosylation.
57. Discuss medically relevant examples of glycosylated proteins such as erythropoietin and the ABO blood group system.
58. Describe the structure and function of ubiquitin.
59. Explain what types of proteins are ubiquitinated and how ubiquitin is attached onto them.
60. Discuss how the proteasome breaks down ubiquitinated proteins.
61. Discuss the synthesis and post translational modifications of collagen.
62. Explain the different types of DNA repair mechanisms and provide examples of each one.
63. Discuss how errors in repair mechanisms can result to cancer.

Lobs covered during lab practical:

64. Perform DNA electrophoresis.
65. Explain how to determine the size of DNA fragments from a gel.

Week 9

Lobs covered during lectures:

66. Revise the stages of the cell cycle.
67. Discuss the checkpoints of the cell cycle.
68. Explain how the cell cycle is regulated and how errors in regulation may result to cancer.
69. Define and provide examples of tumor suppressor genes and oncogenes.
70. Describe the role of p53 in cancer.
71. Discuss the role of viruses, such as HPV, in cancer.

Tutorial:

USMLE Problem solving

Week 10

Lobs covered during lectures:

72. Define apoptosis and necrosis and discuss their differences.
73. Define causes of cell injury and necrosis and describe pathologic processes (e.g. liquefactive necrosis and free radical formation.

74. Discuss the different types of apoptotic pathways.
75. Discuss chemotherapy drugs as inducers of apoptosis.
76. Discuss the role of genes commonly associated with different types of cancer.
77. Discuss briefly the different chromosomal translocations that lead to cancer formation.

Tutorial:
Problem solving

Week 11

Lobs covered during lectures:

78. Describe local and long distance signaling.
79. Describe the different types of receptors and give examples of each.
80. Explain the basic principles of receptor-ligand binding.
81. Describe the general structure of G protein coupled receptors (GPCRs).
82. Describe the epinephrine signaling pathway as an example of a GPCR signaling pathway.
83. Discuss the process of GPCR receptor desensitization.
84. Discuss the phosphoinositide pathway of GPCR signaling.

Tutorial:
Problem solving

Week 12

Lobs covered during lectures*:*

85. Describe the structure of tyrosine kinase receptors.
86. Explain the MAPK signaling pathway of the insulin receptor.
87. Discuss the phosphoinositide 3-kinase branch point of insulin signaling.
88. Discuss the guanylyl cyclase family of tyrosine kinase receptors and provide examples.
89. Discuss signal transduction of cytokine receptors via the JAK-STAT tyrosine kinase receptors.
90. Discuss the structure and function of serine-threonine kinases.
91. Discuss signalling via serine-threonine kinases such as TGF-β.
92. Describe the types of ion channels and their architecture.
93. Discuss basic principles of ion channels such as ion selectivity.
94. Describe the types of adhesion receptors and their functions.
95. Describe the key players of the mTOR pathway.
96. Discuss how errors in the mTOR pathway are linked to cancer.

Tutorial:

- Revision

Course Content:

Topics covered in lectures:

- The pentose phosphate pathway.
- Nucleotide metabolism.
- Metabolism of phospholipids, sphingolipids and eicosanoids.
- Lysosomes and related disorders.
- Metabolism of steroids.
- Metabolism of amino acid derivatives.
- Peroxisomes and related disorders.
- Introduction to nutrition.
- Vitamins and minerals.
- DNA replication, recombination, transcription and translation.
- Protein sorting.
- Post-translational modifications.
- DNA repair.
- The cell cycle.
- Regulation of the cell cycle and implications in cancer.
- Oncogenes and tumor suppressor genes.
- Apoptosis and necrosis.
- Overview of cancer genetics.
- Signal transduction I: basic principles.
- Signal transduction II and III: G Protein Coupled Receptors.
- Signal Transduction IV: Enzyme Coupled Receptors -Tyrosine Kinase Receptors.
- Signal Transduction V: Enzyme Coupled Receptors -Receptor serine-threonine kinases.
- Signal Transduction VII: Ion Channels, Adhesion Receptors & mTOR pathway.

Topics covered in lab practicals:

- Isolation and quantification of DNA from saliva.
- Polymerase chain reaction (PCR).
- Restriction digestion of PCR products.
- DNA electrophoresis.
- Molecular biology and recombinant technology techniques.

Topics covered in tutorials:

- Introduction to lab project.
- Methods in determining DNA sequences.
- Molecular Biology Techniques
- Detecting and Quantifying Gene Expression.
- Problem solving.

Learning Activities and Teaching Methods:

Lectures, Tutorials, Laboratory Practical Sessions.

Assessment Methods:

Coursework (10%), Midterm Exam 30%) and Final Exam (60%). Assessment is by Single Best Answers (SBAs) and Short Answer Questions (SAQs).

Required Textbooks/Reading

Authors	Title	Edition	Publisher	Year	ISBN
David L. Nelson and Michael M. Cox	Lehninger Principles of Biochemistry	7th edition	W. H. Freeman and Company	2017	9781319108243

Recommended Textbooks/Reading

Authors	Title	Edition	Publisher	Year	ISBN
Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter	Molecular Biology of the Cell	6th Edition	Garland Science	2015	ISBN 978-0-8153-4432-2 (hardcover) ISBN 978-0-8153-4464-3 (paperback)
Michael A. Lieberman and Rick Ricer	BRS Biochemistry, Molecular Biology & Genetics	6th edition	Wolters Kluwer / Lippincott Williams & Wilkins	2014	ISBN-13: 978-1451175363
Robert A. Weinberg	The Biology of Cancer	2th edition	Garland Science	2013	9780815342205