Course Code	Course Title	ECTS Credits
MED-208	**Physiology II**	6
School	**Semester**	**Prerequisites**
Medical School	Spring (Semester 4)	Completion of Year 1
Type of Course	**Field**	**Language of Instruction**
Required	Medicine	English
Level of Course	**Year of Study**	**Course Lead:**
Undergraduate	2nd	Dr Marios Panos
		Contributor:
		Dr Avgis Hadjipapas
Mode of Delivery	**Work Placement**	**Co-requisites**
Face-to-face	N/A	None

Objectives of the Course:

The main objectives of the course are:

- To describe fundamental mechanisms underlying normal function of cells, tissues, organs, and organ systems of the human body, commensurate with the requirements for a physician providing primary care to patients.
- To explain basic mechanisms of homeostasis by integrating the functions of cells, tissues, organs, and organ systems.
- To enhance an understanding of anatomy, by linking structure and function.
- To provide a strong scientific basis to Medicine, the clinical counterpart of Physiology.

Learning Outcomes:

The body systems to be covered are: Urinary system, Reproductive system, Central and Peripheral Nervous Systems, Musculoskeletal System, Skin and related connective tissue and Sensory organs. The following list provides the learning objectives (LOBs) that will be covered in the lectures and practicals of each week (please note that no new learning objectives will be covered in tutorials since these will be used to revisit previous topics and answer students' questions):

Week 1

LOBs covered during lectures:

1. Describe innate and adaptive immunity, the role and interaction of T/B lymphocytes and the function of complement.
2. Describe the variety of kidney functions aiming at maintaining homeostasis.
3. Recognise the nephron as the functional unit of the kidney.
4. Describe the process of glomerular filtration, define filtration coefficient and list the factors influencing its performance.
5. Describe renal adaptation and performance during exercise.
6. Describe the process of tubular reabsorption of sodium, glucose and amino acids.
7. Outline factors influencing reabsorption including aldosterone and natriuretic peptide and describe osmotic diuresis.
8. Describe the role of sodium reabsorption is responsible in passive reabsorption of chloride, water and urea.
9. Describe the process of tubular secretion of hydrogen and its role in acid-base balance.
10. Describe potassium secretion and its control by aldosterone.

11. Outline the role of organic anion and cation secretion and its role in eliminating foreign compounds
12. Define plasma clearance and use of inulin and para amino hippuric acid (PAH) in determining filtration fraction.
13. Describe the modulation of urine concentration depending on body needs.
14. Explain the role of long loops of Henle in establishing a vertical osmotic gradient by countercurrent multiplication.
15. Describe the role of vasopressin in controlling water reabsorption in the final tubular segments.
16. Explain the role of the vasa recta in preserving the vertical osmotic gradient by countercurrent exchange
17. Explain how water reabsorption is only partially linked to water reabsorption.
18. Describe the multi-system implications of renal failure.
19. Describe the storage of urine in the urinary bladder and the process of micturition.

Week 2

LOBs covered during lectures:

20. Describe the concept of fluid balance, the internal pool of a substance and that input must equal output.
21. Describe the distribution of body water between the Intra and Extra cellular fluid.
22. Outline that plasma and extracellular fluid are similar in composition but differ markedly from intracellular fluid.
23. Describe how fluid balance is maintained by regulating ECF volume and osmolarity.
24. Describe how ECF volume is important in the long term regulation of blood pressure and the role of salt balance in maintaining ECF volume.
25. Describe how ECF hypo/ hyper/isotonicity influences movement of water into and out of cells.
26. Recognise the importance of vasopressin in regulating ECF osmolarity.
27. Recognise that vasopressin secretion and thirst are triggered largely simultaneously by increases in osmolarity of the ECF.
28. Describe the generation of free hydrogen ions by metabolic processes and that acid liberates hydrogen ions and base accepts them.
29. Describe the concept of pH to express Hydrogen ion concentration.
30. Describe the role of buffer systems and the primary role of the H_2CO_3 : HCO_3^- buffer pair in ECF and protein buffers in the ICF.
31. Describe the role of Haemoglobin as a buffer of H+ generated from CO2 and of phosphate as a buffer in urine.
32. Describe the role of the respiratory system as a second line of defence against changes in H+ concentration.
33. Describe the mechanism by which the kidneys adjust H+ excretion and how they conserve or secrete HCO3- depending on plasma H+ concentration.
34. Describe the process of ammonia secretion during acidosis to buffer secreted H+.
35. Recognise the importance of the kidney as a third line of defence against changes in H+ concentration in plasma.
36. Describe how acid-base imbalances can arise either from metabolic or respiratory causes.
37. Describe the changes in respiratory acidosis or alkalosis.
38. Describe the changes in metabolic acidosis or alkalosis.

Week 3

LOBs covered during lectures:

39. Describe the function of the reproductive system and recognize that it does not participate in homeostasis.
40. Describe the components of the reproductive system i.e. gonads, reproductive tract, accessory sex glands, in males and females.
41. Describe the reproductive cells and recognize that they contain a half set of chromosomes.
42. Describe gametogenesis and how it is accomplished by meiosis resulting in unique sperm and ova.
43. Describe the role of sex chromosomes in determining the sex of an individual.
44. Describe how sex differentiation along male or female lines depends on the presence or absence of masculinizing determinants.
45. Describe the scrotal location of the testes which provides a cooler location for spermatogenesis.
46. Describe the role of Leydig cells in secreting testosterone.
47. Describe the process of spermatogenesis and the association to Sertoli cells.
48. Describe the control of testosterone secretion and spermatogenesis by the LH and FSH secreted by the pituitary.
49. Describe the increase in GnRH and other events which occur at puberty.
50. Describe the storage and concentrating function of sperm by the reproductive tract.
51. Describe the function of the accessory sex glands in contributing the bulk of the seminal fluid.
52. Describe the process of male erection and ejaculation.
53. Explain how orgasm and resolution complete the sexual response cycle.
54. Describe the factors which influence volume and sperm content of the ejaculate.
55. Describe the female sexual cycle and recognize that it is similar to the male cycle.

LOBs covered during lab practicals:

56. Describe the principles of urinalysis and perform urine tests using a multistick.
57. Describe the significance of the presence of red blood cells and casts at urine microscopy.
58. Describe the principles of measuring urine specific gravity by the use of a refractometer.
59. Carry out an experiment in which healthy volunteers are subjected to a salt load, a salt and water load or a water load and use timed collections of urine to establish the response of the kidney in terms of urine flow rate and changes in urine osmolality, as estimated by changes in urine specific gravity.

Week 4

LOBs covered during lectures:

60. Form an overall view of the female hormonal and ovarian cycle.
61. Describe the steps of gametogenesis during the female ovarian cycle.
62. Describe the formation of Primary and secondary oocytes and the formation of the mature ovum.
63. Describe the ovarian cycle in terms of alternating follicular and luteal phases and the changes in hormonal secretion controlling these phases.
64. Describe the complex hormonal interactions which control the ovarian cycle.
65. Describe the changes which occur in the uterus at different stages of the ovarian cycle.
66. Describe events occurring at puberty in females.
67. Explain the physiology of menstruation from menarche to menopause and consequences.
68. Describe possible effects of exercise on the menstrual cycle, amenorrhea.

69. Describe the effect of fluctuating oestrogen and progesterone levels on cervical mucus.
70. Describe pubertal changes in females and recognize the similarity to those in males.
71. Describe menopause and its uniqueness to females.
72. Describe the main chemical features of oestrogen and progesterone and their synthetic analogues and explain how they exert their contraceptive effect.
73. Describe the process of ovulation, fertilization, implantation and identify the role of trophoblastic enzymes in blastocyst implantation in the endometrium.
74. Describe the role of the placenta in hormone secretion for the maintenance of pregnancy and in exchanges between fetal and maternal circulation.
75. Describe the response of maternal body systems to the increased demands of pregnancy.
76. Describe changes during gestation in preparation for parturition.
77. Describe the normal physiological changes that occur during labour and in the puerperium.
78. Describe the positive feedback cycle which occurs to accomplish parturition.
79. Outline the physiological changes in the fetus at first breath.
80. Describe the structure of the breast and outline the endocrine control of lactation.
81. Describe the benefits of breast feeding.

Week 5

LOBs covered during lectures:

82. Describe the overall organization of the CNS.
83. Describe the 3 functional classes of neurons.
84. Describe the properties of neurons, glial cells and astrocytes.
85. Describe the structure and function of the meninges –dura, arachnoid, pia matter.
86. List the functions of the cerebrospinal fluid and describe its production, flow and removal in the brain and spinal cord.
87. Describe the blood–brain barrier and its function.
88. Describe the gross anatomy of the brain and its components.
89. Give an account of the function of the cerebral cortex and its functional divisions.
90. Describe the function and connections of the occipital, temporal, parietal and frontal lobes, including aphasia, agnosia and apraxia.
91. Describe the function of the primary motor cortex and its control of muscles and the sensory and motor homunculus.
92. Describe the concept of plasticity of the brain.
93. Describe higher functions of the cortex e.g. language.

Week 6

LOBs covered during lectures:

94. Describe the role of basal nuclei in relaying sensory signals and motor control.
95. Outline the role of the hypothalamus in homeostatic functions.
96. Describe the limbic system and its role in emotion and behavioural patterns.
97. List the neurotransmitters and describe their role in pathways for emotions and behaviour.
98. Describe the role of the limbic system in learning and memory.
99. Describe the molecular processes involved in short and long-term memory and mechanisms of habituation, sensitization and long term potentiation.
100. Describe the role of hippocampus in declarative, cerebellum in procedural and prefrontal cortex in working memory.

101. Outline the role of the cerebellum in balance, planning and executing voluntary movement.
102. Outline the normal effects of the cerebellum on descending motor systems.
103. Revise the role of the basal ganglia in the control of posture, movement and locomotion.
104. Describe the role of the brain stem (medulla, pons, midbrain) in linking the spinal cord to higher brain regions.
105. Describe the role of the reticular activating system.
106. Describe the concept of consciousness and the role of the electroencephalogram in recording brain activity.
107. Describe the sleep -wake cycle and its components.
108. Review the basic anatomy of the Spinal Cord, grey and white matter, dorsal and ventral horns.
109. Describe the ascending and descending pathways in the white matter of the spinal cord.
110. Describe the role of the spinal cord in integrating reflexes and the reflex arc.
111. Give an account of the categories of reflexes, revise balance.
112. Describe the distribution of dermatomes.
113. Describe the features of Alzheimer's disease and dementia and the possible role of beta amyloid plaques, Tau Tangles.
114. Review the Central Nervous system (lectures 1-4).

Week 7

LOBs covered during lectures:

115. Describe the concept of receptor differential sensitivities to various stimuli.
116. List receptors according to their adequate stimulus.
117. Describe the mechanism of graded and action potential generation by receptors.
118. Describe the processes of receptor adaptation, 'labelling' according to modality and allocation and factors influencing acuity.
119. Outline the process of perception.

MIDTERM EXAM

Week 8

LOBs covered during lectures:

120. Describe the characteristics and categories of pain receptors, the role of higher processing of pain input and outline the concept of phantom pain.
121. Outline the role of endorphins and enkephalins as the brain's innate analgesic system and the mode of action of acupuncture.
122. Describe protective mechanisms that prevent eye injuries, eyelids, tears.
123. Describe the basic anatomy and constituents of the eye and their function.
124. Outline the function of the iris in controlling light entering, the lens in refraction and accommodation.
125. Describe the different layers of the retina and their properties and photo-transduction.
126. Discuss photoreceptor activity in the light and dark.
127. Describe the function of rods and cones and visual acuity.
128. Describe the process of colour vision.

129. Describe the processing of visual information and its transmission to the primary visual cortex.
130. Describe the elaboration of the visual message by the thalamus and visual cortex, depth perception and the hierarchy of visual processing.
131. Describe the transfer of visual input to other areas of the brain concerned with alertness, external eye muscles and diurnal rhythm.

Week 9

LOBs covered during lectures:

132. Outline the anatomy and explain the role of the external, middle and inner ear in locating transmitting and amplifying sound.
133. Explain the generation of sound waves and the meaning of pitch, tone, intensity (loudness), quality of sound (timbre) and hearing threshold.
134. Explain the conversion of tympanic membrane vibrations into fluid movements in the inner ear and the function of the cochlea.
135. Explain the transduction of fluid movements into neural signals by the organ of Corti.
136. Describe the role of the CNS in pitch discrimination, loudness and timbre.
137. Distinguish conductive, sensorineural deafness and describe neural presbyacusis and the role of hearing aids and cochlear implants
138. Describe the structure and role of the vestibular apparatus and its components, the semicircular canals and the otolith organs.
139. Describe the mechanisms of detection of head position and motion by the vestibular apparatus.
140. Outline the mechanisms of motion sickness and vertigo.
141. Describe the location and mechanisms of taste receptors in tongue taste buds and the further transfer and processing of taste signals in the gustatory pathway.
142. Describe the mechanism of detection of sour, sweet, bitter and umami taste.
143. Recognise the presence of taste receptors in gut and airways.
144. Describe olfactory receptors in the nose, the mechanism of detection of smell, and the processing in the olfactory bulb.
145. Describe the transfer and processing of smell signals in the olfactory system.
146. Outline the role of the vomeronasal organ in detecting pheromones.
147. Distinguish the autonomic and somatic nervous systems.
148. Describe the autonomic two-neuron chain and the CNS origins of the sympathetic and parasympathetic nervous systems.
149. Distinguish transmitters in the sympathetic and parasympathetic postganglionic fibres.
150. Recognize the dual innervation by para and sympathetic systems in most organs.
151. Describe the concept of sympathetic/ parasympathetic tone and dominance by the sympathetic or parasympathetic systems.
152. Recognize the adrenal medulla as a modified part of the sympathetic nervous system.
153. Give an account of receptor types for each autonomic neurotransmitter (cholinergic and adrenergic) and the role of autonomic agonists and antagonists.

154. Describe the role of the CNS in the control of autonomic reflexes and activities e.g. urination, defaecation, cardiovascular, digestive, endocrine.
155. Describe Motor neurons as the final common pathway.
156. Revise the functional architecture of the neuromuscular Junction.
157. Revise the events occurring at the neuromuscular junction, the role of acetylcholine, acetylcholinesterase, the influence of specific chemical agents and diseases on the neuromuscular junction.
158. Compare efferent neurons of the Autonomic N.S. to somatic NS motor neurons.
159. Compare afferent neurons to Efferent Autonomic Neurons & Efferent Somatic Neurons and Interneurons.

Week 10

LOBs covered during lectures:

160. Describe, draw and label the blood supply to the cerebral cortex, cerebellum, brainstem, and spinal cord.
161. Identify CNS areas affected due to ischaemia according to the site of the vascular lesions (stroke).
162. Discuss the major factors that influence cerebral blood flow and describe its regulation and revise the function of the blood brain barrier.
163. Explain the pathophysiology of elevated intracranial pressure, and describe the influence of cerebral perfusion, blood pressure, blood gases and fluid balance.
164. List and distinguish between the major types of aphasia, agnosia and apraxia.

Week 11

LOBs covered during lectures:

165. Describe the normal processes of embryonic development, foetal maturation, and perinatal changes.
166. Describe the normal cell/tissue structure and function, including barrier functions, thermal regulation, and eccrine function.

Week 12

LOBs covered during lectures:

167. Describe the processes of repair, regeneration, and changes associated with stage of life or ethnicity.
168. Describe the effects of exercise and physical conditioning.
169. Describe the processes of repair, regeneration and changes associated with stage of life.
170. Describe the effects of age related degeneration in the brain and factors contributing to the preservation of function.
171. Describe the extent feasible and the process for limited regeneration in the CNS.
172. Describe age related changes in kidney function and inability to regenerate / repair and extent of compensatory hypertrophy of the contralateral kidney.

Course Contents:

Lectures:

- BODY DEFENCES: Innate and Adaptive Immunity.
- BODY DEFENCES: B and T lymphocytes and immune diseases.
- URINARY SYSTEM: Kidneys- Anatomy, functions and basic processes.
- URINARY SYSTEM: Renal tubular secretion.
- URINARY SYSTEM: Kidneys- Urine extretion and plasma clearance.
- URINARY SYSTEM: Kidneys- Fluid Balance I.
- URINARY SYSTEM: Kidneys- Acid Base Balance.
- URINARY SYSTEM: Acid base balance control.
- URINARY SYSTEM: Review of basic renal functions and plasma clearance.
- URINARY SYSTEM: Review of fluid and acid base balance.
- REPRODUCTIVE SYSTEM: Introduction.
- REPRODUCTIVE SYSTEM: Male Reproductive Physiology.
- REPRODUCTIVE SYSTEM: Sexual intercourse between males and females.
- REPRODUCTIVE SYSTEM: Female Reproductive Physiology.
- REPRODUCTIVE SYSTEM: Physiology of Pregnancy
- REPRODUCTIVE SYSTEM: Physiology of Parturition (giving birth), labour and puerperium.
- REPRODUCTIVE SYSTEM: Review of the Reproductive System.
- CENTRAL NERVOUS SYSTEM AND PERIPHERAL NERVOUS SYSTEM: Organisation and cells of the CNS.
- CENTRAL NERVOUS SYSTEM AND PERIPHERAL NERVOUS SYSTEM: Overview of the CNS.
- CENTRAL NERVOUS SYSTEM AND PERIPHERAL NERVOUS SYSTEM: Basal Nuclei, Thalamus, Hypothalamus and the Limbic System.
- CENTRAL NERVOUS SYSTEM AND PERIPHERAL NERVOUS SYSTEM: The Cerebellum, Brain stem and spinal cord.
- CENTRAL NERVOUS SYSTEM AND PERIPHERAL NERVOUS SYSTEM: Spinal cord, reflexes, dermatomes.
- CENTRAL NERVOUS SYSTEM AND PERIPHERAL NERVOUS SYSTEM: Alzheimer's Disease and Review of the CNS.
- THE PERIPHERAL NERVOUS SYSTEM: Receptor Physiology.
- THE PERIPHERAL NERVOUS SYSTEM: Pain Perception.
- THE PERIPHERAL NERVOUS SYSTEM: The Eye - Vision.
- THE PERIPHERAL NERVOUS SYSTEM: The Ear- Hearing.
- THE PERIPHERAL NERVOUS SYSTEM: The Inner Ear - Equilibrium (Balance).
- THE PERIPHERAL NERVOUS SYSTEM: Chemical senses (Taste and Smell).
- THE PERIPHERAL NERVOUS SYSTEM: Efferent Division. The Autonomic Nervous System. Sympathetic and Parasympathetic Nervous Systems.
- THE PERIPHERAL NERVOUS SYSTEM: Comparison of the Autonomic and Somatic Nervous Systems and Review of Autonomic Nervous System.
- Anatomy of cerebral circulation.
- Regulation of cerebral blood flow.
- Raised Intracranial Pressure, haematoma and the aphasias.
- SKIN AND RELATED CONNECTIVE TISSUE.

- Review of the CENTRAL NERVOUS SYSTEM.

Lab practicals:

- RENAL AND ACID BASE PRACTICAL.
- THE PERIPHERAL NERVOUS SYSTEM PRACTICAL.

Tutorials:

- Renal and acid base calculations/ exercises.

Learning Activities and Teaching Methods:

Lectures, Practicals, Tutorials.

Assessment Methods:

Oral presentation (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
Sherwood, Laura Lee	Human Physiology: from Cells to Systems	9th Edition	CENGAGE Learning	2015	9781305264038 ("Looseleaf " i.e., pbk)

Recommended Textbooks/Reading:

Authors	Title	Edition	Publisher	Year	ISBN
Costanzo, Linda	Physiology	5th Edition	Saunders/ Elsevier	2014	9781455708475
Costanzo, Linda	BRS: Physiology	6th Edition	Lippincott Williams & Wilkins	2014	9781469832005
Chandar, Nalini	Lippincott's Illustrated Reviews: Cell & Molecular Biology	6th Edition	Lippincott Williams & Wilkins	2010	9781609133092