

## Neuro-endocrine Functions, Excretion and Reproduction module

Year 2 Semester 1

Credits: 8

Responsible Department: Department of Physiology

Module Coordinator: Head / Physiology

	Topic	Objectives	Time (Hrs)	T/L activity	Dept
		<b>The student should be able to,</b>			
<b>Excretion</b>					
	<b>GFR and factors affecting GFR</b>	<ol style="list-style-type: none"> <li>1. Recall / describe the functional anatomy of the kidney.</li> <li>2. Describe the functional unit of the kidney.</li> <li>3. Explain in sequence the blood vessels through which blood flows from the renal artery to the renal vein, including the glomerular blood vessels, peritubular capillaries, and the vasa recta.</li> <li>4. List different types of nephrons and state the structural and functional differences between them.</li> <li>5. Explain the processes in urine formation – filtration, secretion and reabsorption.</li> <li>6. Describe the glomerular membrane (layers and its permeability characteristics).</li> <li>7. State the composition of the glomerular filtrate.</li> <li>8. Explain the terms Glomerular Filtration Rate (GFR) and filtration fraction and give their normal values.</li> <li>9. Describe the factors affecting GFR.</li> <li>10. Explain the mechanisms which regulate GFR.</li> </ol>	2 h	Lecture	Physiology

	<b>Tubular functions</b>	<ol style="list-style-type: none"> <li>1. Compare the structural characteristics and the absorptive properties of the epithelial cells in the proximal tubule, thin and thick segments of the loop of Henle, the diluting segment, the late distal tubule and the collecting duct.</li> <li>2. Explain the process of tubular reabsorption of different solutes and water.</li> <li>3. Explain the concept of tubular maximum as applied to glucose transport.</li> <li>4. Describe the process of reabsorption of electrolytes <math>\text{Na}^+</math>, <math>\text{K}^+</math>, <math>\text{Cl}^-</math> and <math>\text{HCO}_3^-</math> by the tubules.</li> <li>5. Explain the mechanism of <math>\text{K}^+</math> reabsorption and secretion in the renal tubules</li> </ol>	2h	Lecture	Physiology
	<b>Clearance</b>	<ol style="list-style-type: none"> <li>1. Explain the concept of renal clearance and indicate how clearance of a substance is affected by reabsorption and secretion.</li> <li>2. Explain how GFR can be measured by using inulin and creatinine and state the advantages and disadvantages of the above substances as measures of GFR.</li> <li>3. Explain how PAH (para-aminohippuric acid) is used to measure renal plasma flow.</li> </ol>	1h	Lecture	Physiology
	<b>Renal handling of water</b>	<ol style="list-style-type: none"> <li>1. Explain how the loop of Henle functions as a countercurrent multiplier and the vasa recta function as countercurrent exchangers.</li> <li>2. Explain mechanisms of producing concentrated and dilute urine.</li> <li>3. Explain the hypothalamic mechanism controlling ADH secretion and thirst.</li> <li>4. State the normal range of volume, specific gravity and osmolality of urine.</li> <li>5. Explain the terms: water diuresis, osmotic diuresis, pressure diuresis.</li> </ol>	2h	Lecture	Physiology
	<b>Role of the kidney in Acid-Base balance</b>	<ol style="list-style-type: none"> <li>1. Explain how <math>\text{HCO}_3^-</math> and <math>\text{H}^+</math> handling by the kidneys help in maintaining acid base balance.</li> <li>2. Explain the mechanism of transport of <math>\text{H}^+</math> and <math>\text{HCO}_3^-</math> in the proximal and distal tubular segments.</li> <li>3. Describe how <math>\text{H}^+</math> are buffered in the kidney by the following; <ul style="list-style-type: none"> <li>(i) ammonia buffer</li> <li>(ii) bicarbonate buffer</li> <li>(iii) phosphate buffer</li> </ul> </li> </ol>	1h	Lecture	Physiology

	<b>Acid-base and electrolyte disturbances</b>	<ol style="list-style-type: none"> <li>1. Recall the normal regulation of acid base balance in the Respiration and Excretion modules.</li> <li>2. Explain the terms respiratory and metabolic acidosis and Alkalosis.</li> <li>3. Indicate the causes of acid base disorders and explain the basis of the changes in bicarbonate and PCO<sub>2</sub> in these conditions.</li> <li>4. State the compensatory changes that occur in the conditions mentioned.</li> </ol>	2h	Lecture	Physiology
	<b>Homeostatic Functions of the kidneys</b>	<ol style="list-style-type: none"> <li>1. Explain the renin-angiotensin-aldosterone mechanism in relation to maintaining blood pressure, fluid and electrolyte balance.</li> <li>2. Describe the role of the hypothalamic osmoreceptors and ADH in controlling ECF osmolality.</li> <li>3. Describe the role of the thirst mechanism in controlling ECF osmolality.</li> <li>4. Explain the effect of arterial baroreceptors, low pressure receptors, ANP, aldosterone and ADH in maintaining blood volume and ECF volume.</li> </ol>	2h	Lecture	Physiology
	<b>Renal handling of water</b>	<ol style="list-style-type: none"> <li>1. explain the role of ADH in producing a dilute urine.</li> <li>2. explain how the loop of Henle functions as a countercurrent multiplier and the vasa recta function as countercurrent exchangers.</li> <li>3. explain the role of ADH and the countercurrent mechanism in concentrating urine.</li> <li>4. explain the hypothalamic mechanism controlling ADH secretion and thirst.</li> <li>5. state the normal range of volume, specific gravity and osmolality of urine.</li> <li>6. explain the terms: water diuresis, osmotic diuresis, pressure diuresis.</li> <li>7. measure volume and specific gravity of urine.</li> <li>8. assess the excretion of water and solutes under resting conditions and after ingestion of different fluid/solute loads</li> </ol>	3h	Practical	Physiology
	<b>Micturition</b>	<ol style="list-style-type: none"> <li>1. Describe the functional anatomy of the urinary bladder including the innervations.</li> <li>2. Describe the micturition reflex and explain how it is modified by centers in the brain stem and cerebral cortex.</li> <li>3. Describe the pressure changes in the bladder with increase of its volume (physiological basis of cystometrogram).</li> <li>4. Explain the physiological basis of bladder dysfunction in neurological lesions.</li> </ol>	1h	Lecture	Physiology
	<b>Dehydration</b>	<ol style="list-style-type: none"> <li>1. Explain the regulatory mechanisms which maintain extracellular fluid (ECF) volume and osmolarity.</li> <li>2. Explain the basis of different forms of dehydration</li> </ol>	1 hr	Lecture	Physiology



	<b>Ovarian cycle and female sex hormones</b>	<ol style="list-style-type: none"> <li>1. Describe the hormonal, functional and histological changes during the ovarian and uterine cycles.</li> <li>2. Describe the regulation of the reproductive cycle in the female.</li> <li>3. Describe the physiological effects of estrogens and progesterone.</li> <li>4. Explain the changes that occur in the female reproductive system at menopause.</li> </ol>	3hrs	Lecture	Physiology
	<b>Sexuality and sexual response</b>	<ol style="list-style-type: none"> <li>1. Explain the neuronal mechanisms and the psychic stimuli involved in the male and female during the sexual act.</li> <li>2. State the stages of the male and female sexual response and explain the physiological changes occurring in each stage.</li> </ol>	1h	Lecture	Physiology
	<b>Fertilization, tubal functions and implantation</b>	<ol style="list-style-type: none"> <li>1.State the period of viability of the sperm and ovum in the female genital tract.</li> <li>2.Describe the process, timing and site of fertilization.</li> <li>3.Describe the structural and functional changes of the endometrium following implantation and embryonic development.</li> </ol>	1h	Lecture	Physiology
	<b>Contraceptives</b>	<ol style="list-style-type: none"> <li>1. State the different types of contraception.</li> <li>2. Explain the mechanism of action of the different contraceptive methods.</li> </ol>	1h	Lecture	Physiology
	<b>Pregnancy</b>	<ol style="list-style-type: none"> <li>1.Describe the hormonal and physiological changes in a pregnant female.</li> <li>2.Describe the functional anatomy of the placenta.</li> <li>3.Explain the processes of diffusion of O<sub>2</sub>, CO<sub>2</sub> and nutrients across the placenta.</li> <li>4.State the excretory functions of the placenta.</li> </ol>	2 hrs	Lecture	Physiology

	<b>Parturition, puerperium and lactation</b>	<ol style="list-style-type: none"> <li>1. Describe the patterns of uterine contractions during pregnancy and labour.</li> <li>2. Explain the physiological events taking place during parturition.</li> <li>3. List the hormones involved in lactation and describe their role.</li> <li>4. Describe the process of milk ejection and the role of oxytocin in milk ejection.</li> </ol>	1hrs	Lecture	Physiology
		<ol style="list-style-type: none"> <li>1. Explain the mechanism of Labour.</li> </ol>	1 hr	Lecture	Gyn. & Obs.
	<b>Physiology of the fetus</b>	<ol style="list-style-type: none"> <li>1. Describe the functional development of circulatory system and respiratory system of the fetus.</li> <li>2. Describe the fetal adaptations for gas exchange.</li> <li>3. Explain the readjustments at birth and changes in the neonatal period of the blood, circulation, respiration, kidneys, liver, digestive system, body temperature, metabolism and nervous system.</li> </ol>	2h	Lecture	Physiology
	<b>Round-up</b>		2hrs	SGD	Physiology
<b>Endocrine functions</b>					
	<b>Functional organization of the endocrine system</b>	<ol style="list-style-type: none"> <li>1. Define the term 'hormone'.</li> <li>2. List the different types of hormones based on the chemical structure and describe their mode of action.</li> <li>3. Explain the terms first messenger and second messenger giving examples</li> <li>4. List the hormones secreted by the following endocrine glands: Hypothalamus, Pituitary, Thyroid, Parathyroid, Adrenal cortex and medulla, Gonads and placenta, Endocrine pancreas. Gastrointestinal system, Kidney, Heart and vascular endothelium, Pineal gland.</li> </ol>	1 hr	Self-study	Physiology
	<b>Pituitary and hypothalamus</b>	<ol style="list-style-type: none"> <li>1. Describe the synthesis, secretion and transport of hypothalamic factors/hormones.</li> <li>2. Describe the function of the hypothalamo-hypophysial portal system.</li> <li>3. State the anterior pituitary hormones and the cells responsible for their secretion.</li> <li>4. Describe the functions of hypothalamic releasing factors/ hormones</li> </ol>	2 hr	Lecture	Physiology

		involved in regulating the secretions of the anterior pituitary gland. 5. Describe the actions of anterior pituitary hormones on target tissues, glands and organs. 6. Describe the regulation of secretion of Anterior pituitary hormones. 7. List the hormones of the posterior pituitary gland. 8. Describe their synthesis and transport to the posterior pituitary gland. 9. Describe their actions on target tissues, glands and organs. 10. Describe the regulation of these hormones.			
	<b>Hypopituitarism and Hyperpituitarism</b>	1 Describe the effects of hypo and hyper secretion of the hormones secreted by the pituitary gland. 2 Describe the effects of the enlargement of the pituitary gland.	1 hr	Lecture	Physiology
	<b>Thyroid</b>	1 Outline the functional histology of the thyroid gland. 2. List the hormones secreted by the thyroid gland. 3. Describe the steps involved in the synthesis and storage of thyroid hormones. 4. Describe the process of release of thyroid hormone into the blood. 5. List the proteins that bind thyroid hormones in plasma. 6. State the relationship between bound and free thyroid hormones in blood. 7. Explain the mechanism of action of thyroid hormones at the cellular level. 8. Describe how thyroid hormones are catabolised. 9. Explain the mechanisms by which the secretion of thyroid hormones are regulated by the hypothalamic-pituitary axis. 10. Describe the physiological actions of thyroid hormones.	1 hr	Lecture	Physiology
	<b>Derangement of thyroid function</b>	1. Explain the physiological effects of hyper and hypo function of the thyroid gland.	1 hr	Lecture	Physiology
	<b>Parathyroid</b>	1. Describe the role of the parathyroid hormone in calcium, phosphate and bone metabolism. 2. Describe the effects of parathyroid hormone on the kidneys, bone, intestine in calcium homeostasis. 3. Describe the regulation of parathyroid hormone secretion. 4. Describe the clinical features and their physiological basis in hyper and hypo function of the parathyroid gland. 5. Explain the derangements of vitamin D and Calcium metabolism.	2hr	Lecture	Physiology
	<b>Adrenal cortex</b>	1. List the hormones secreted by each layer of the adrenal cortex. 2. Describe the regulation of secretion of adrenocortical hormones. 3. State the cyclical pattern of secretion of glucocorticoids and their regulatory	2 hr	Lecture	Physiology

		hormones. 4. Describe the effects of each of the adrenocortical hormones. 5. Describe the clinical features and their physiological basis in hyper and hypo function of the adrenal gland.			
	<b>Adrenal medulla</b>	1. List the catecholamines secreted by the adrenal medulla. 2. Describe the actions of the catecholamines. 3. List the principal metabolites of adrenaline and noradrenaline. 4. List the stimuli which increase adrenal medullary secretions. 5. Discuss the interaction between the adrenal medullary hormones and the sympathetic nervous system.	1 hr	Lecture	Physiology
	<b>Endocrine pancreas</b>	1. List the hormones secreted by the endocrine pancreas and state the cell type involved in their secretion. 2. Explain the mechanism of secretion of insulin. 3. Describe the physiological actions of insulin and glucagon. 4. Outline the blood glucose homeostasis. 5. Explain the basis of occurrence, clinical features and complications of diabetes mellitus.	2hr	Lecture	Physiology
	<b>Other hormones</b>	Describe the role of the gut, kidney, heart, pineal gland, vascular endothelium and adipose tissue as endocrine organs.	1hr	Lecture	Physiology
	<b>Endocrine function and dysfunction</b>	Round up on endocrine function.	2 hrs	SGD	Physiology
<b>Neural Functions</b>					
	<b>Overview of the functions of the nervous system</b>	1. Outline the functional organization of the receptors, effectors and the afferent and efferent pathways. 2. State the structural components of a nerve cell and outline their functions. 3. List the key functional areas of the motor cortex and the sensory cortex. 4. Explain the concept of the upper motor neurone and the lower motor neurone in the motor pathways.	1 hr	Lecture	Physiology



		<ol style="list-style-type: none"> <li>5. Explain the concept of hemispheric lateralization of the brain.</li> <li>6. Explain the concept of the homunculus.</li> </ol>			
	<b>Sensory functions of the nervous system</b>  <b>(a) General sensations</b>	<ol style="list-style-type: none"> <li>1. List the general sensations and special sensations.</li> <li>2. Explain the functional anatomy and signal transduction of sensory receptors.</li> <li>3. Describe the ascending sensory pathways and illustrate the concept of 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order neurons by use of a diagram.</li> <li>4. State the functional localization of the somatosensory cortex.</li> </ol>	2hrs	Lecture	Physiology
	<b>(b) Special sensations</b>  <b>(i) Physiology of vision</b>	<ol style="list-style-type: none"> <li>1. Explain the basic principles underlying the optics of vision.</li> <li>2. Explain the mechanism of accommodation of the lens.</li> <li>3. Explain the basis of errors of refraction and their correction.</li> <li>4. Outline the components of near response and explain their mechanism.</li> <li>5. Explain the pupillary light reflex.</li> <li>6. Explain the principles underlying visual acuity and depth perception.</li> <li>7. Describe different types of eye movements.</li> <li>8. Describe the functions of the retina including photochemistry of vision.</li> <li>9. Explain the mechanisms of dark and light adaptation.</li> <li>10. State the different types of colour blindness and explain their genetic basis.</li> <li>11. Draw a labelled diagram showing the visual pathways from the retina up to the occipital cortex, and describe the effects on vision caused by lesions at the following sites: optic nerve, optic chiasma, optic tract, optic radiation and occipital cortex.</li> </ol>	4 hrs	Lecture	Physiology
	<b>(ii) Testing visual acuity, visual fields and colour vision</b>	<ol style="list-style-type: none"> <li>1. Perform the tests of visual acuity (near and distant vision) and colour vision and interpret the results.</li> <li>2. Examine the optic fundus using an ophthalmoscope.</li> <li>3. Assess visual fields using the confrontation method and interpret the findings.</li> <li>4. Explain the basis of perimetry in visual field assessment and interpret the results.</li> </ol>	3hrs	Practical	Physiology
	<b>(iii) Physiology of hearing</b>	<ol style="list-style-type: none"> <li>1. Explain the properties of sound with special reference to frequency and loudness.</li> <li>2. Explain the mechanism of transmission of sound by air and bone conduction.</li> <li>3. Explain the function of the cochlea and auditory signal transduction.</li> <li>4. Outline the auditory pathways from cochlea to the temporal cortex.</li> </ol>	2hrs	Lecture	Physiology

		5. Explain the basis of conduction and sensorineural deafness.			
	<b>(iv) Tests of hearing</b>	1. Perform Rinne's and Weber's tests and interpret the results. 2. Perform an auriscope examination and identify the anatomical structures in a normal ear. 3. Explain the basis of pure-tone audiometry and interpret the findings.	3 hrs	Practical	Physiology
	<b>(v) Smell and taste</b>	1. Describe the functional anatomy of the olfactory membrane. 2. Explain the mechanism of stimulation of olfactory receptors. 3. Describe the olfactory pathway. 4. Describe the functional anatomy of taste buds and state their locations. 5. State the primary taste modalities. 6. Explain the term 'taste threshold'. 7. Describe the taste pathway. 8. Explain the role of smell and taste in the perception of 'flavour'.	1hr	Lecture	Physiology
	<b>(vi) Pain</b>	1. Define the term 'pain' and state different types of pain (somatic, visceral, neuropathic). 2. Explain terms used to describe different states of pain perception: hyperesthesia, allodynia, hyperalgesia, neuralgia, analgesia, anaesthesia, paraesthesia. 3. State the main features of nociceptors. 4. List the stimuli that can excite nociceptors and explain the role of prostaglandins in sensitizing the nociceptors. 5. Trace the ascending pathway through which pain impulses are transmitted. 6. Describe the central projections of the pain pathway and explain their role in pain perception. 7. Describe the role of substance P in pain impulse transmission. 8. Describe the descending pain modulatory system. 9. List the opioid peptides that are involved in pain inhibition and describe their actions. 10. Discuss the gate-control theory of pain. 11. Explain the role of other neurotransmitters involved in pain modulation. 12. Define the term 'referred pain' and explain its physiological basis. 13. Describe the physiological basis of different methods of pain relief	2 hrs	Lecture	Physiology
	<b>Motor functions (a) Introduction</b>	1. State the functional localization of the primary motor cortex. 2. Outline the descending motor pathways.	1hr	lecture	Physiology
	<b>(b) Reflexes and control of motor functions</b>	1. Explain the physiological basis of reflexes. 2. Explain the mechanisms of stretch reflex and the Golgi tendon reflex. 3. Explain the basis of withdrawal reflex and crossed extensor reflex. 4. Define the term muscle tone.	4 hrs	lectures	Physiology

		<ol style="list-style-type: none"> <li>5. Explain the role of the gamma motor neurone in maintaining muscle tone.</li> <li>6. Discuss the supraspinal control of spinal cord reflexes.</li> <li>7. Explain the cortical &amp; brain stem control of motor functions including the role of premotor cortex and supplementary motor cortex.</li> <li>8. Explain the functions of the reticular formation.</li> <li>9. Explain the physiological basis of the clinical features of upper motor and lower motor neuron lesions.</li> </ol>			
	<b>(c) Cerebellum and motor coordination</b>	<ol style="list-style-type: none"> <li>1. Describe the functional anatomy of the cerebellum and its main input and output connections.</li> <li>2. Explain the role of the cerebellum in motor coordination and maintenance of posture, balance and muscle tone.</li> <li>3. List the clinical features seen in cerebellar disorders and explain their physiological basis.</li> </ol>	2 hrs	lecture	Physiology
	<b>(d) Basal Ganglia</b>	<ol style="list-style-type: none"> <li>1. Name the basal ganglia and state their locations.</li> <li>2. Explain the role of the basal ganglia in motor functions.</li> <li>3. List the neurotransmitters in the basal ganglial circuits and state their functions.</li> <li>4. Describe the clinical features of basal ganglia dysfunction.</li> </ol>	2 hrs	lecture	Physiology
	<b>(e) Posture</b>	<ol style="list-style-type: none"> <li>1. List the sensory inputs, the levels of integration and the reflexes involved in the maintenance of posture.</li> <li>2. Describe the reflexes integrated at the spinal cord level including stretch reflex, positive supporting reaction, negative supporting reaction and righting reflexes.</li> <li>3. Explain the effects of transection of spinal cord and brain stem at different levels, including the following phenomena: spinal shock, decerebrate rigidity and decorticate rigidity.</li> </ol>	1 hr	Lecture	Physiology
	<b>(f) Physiology of Balance</b>	<ol style="list-style-type: none"> <li>1. Describe the functional anatomy of the vestibular apparatus.</li> <li>2. Explain the role of different components of the vestibular apparatus (semicircular canals, utricle and saccule) in detecting static and dynamic posture.</li> <li>3. Describe the afferent and efferent connections of the vestibular nuclei.</li> <li>4. Explain the role of the vestibular apparatus and the vestibular nuclei in maintenance of posture and balance.</li> <li>5. Explain the physiological basis of nystagmus.</li> <li>6. Explain the basis of the tests used to assess balance.</li> </ol>	2 hrs	Lecture	Physiology
	<b>Cognitive functions</b> <b>(a) Physiology of</b>	<ol style="list-style-type: none"> <li>1. Describe the physiological basis of memory.</li> <li>2. Describe the terms: immediate, short-term and long-term memory.</li> <li>3. Explain the mechanisms involved in formation of long term memory.</li> </ol>	2 hrs	Lecture	Physiology

	<b>memory and functions of the limbic system</b>	4. State the brain areas involved in memory. 5. Describe the functions of the limbic system.			
	<b>(b) Speech and language</b>	1. Describe the structures and mechanisms involved in phonation and articulation. 2. Describe brain areas and the mechanisms involved in central control of speech. 3. Explain the basis of speech disorders.	1 hr	Lecture	Physiology
	<b>(c) Sleep and Arousal</b>	1. Explain the physiological basis of electroencephalography (EEG). 2. State the different waves seen in a typical EEG tracing. 3. State the different stages of sleep and describe a typical sleep cycle. 4. Compare and contrast slow wave sleep and REM sleep. 5. Discuss the role of the reticular system in arousal and sleep. 6. State the neurotransmitters involved in arousal and sleep. 7. Describe the EEG patterns seen in different stages of sleep.	2 hr	Lecture	Physiology
	<b>Physical examination of the nervous system</b> (a) Sensory (b) Cranial nerves (c) Motor	2. Perform complete clinical examination of the nervous system.	9hrs	3 hrs for sensory 3 hrs for cranial nerves 3 hrs for motor function  Practical	Physiology
	<b>Sleep &amp; Arousal</b>				
	<b>Investigation of neural functions</b>	1. Explain the basis of neurophysiological tests and be able to interpret their results.	3 hrs	Practical	Physiology
	<b>Applied Physiology of neurological disorders</b>	1. Localize spinal cord lesions based on the clinical picture.	2hrs	SGD	Physiology