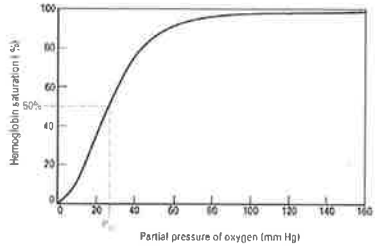
ACEM PRIMARY 2013/1 Physiology VIVA **Morning Session 1** ***Candidate Number:*** **AGREED MARK:**

TOPIC	QUESTIONS	KNOWLEDGE **(essential in bold)**	NOTES
Question 1: LOCAL FLOW REGULATION LOA: 2	a. Describe the autoregulation of tissue blood flow. Prompt: what are the main features of autoregulation	Capacity of tissues to regulate their own blood flow Tissue blood **flow remains relatively constant** despite moderate **changes in perfusion pressure** through alterations in **vascular resistance.**	Three main features to pass
	b. How would this apply to autoregulation of cerebral blood flow?	**Constant flow over arterial pressure range 65-140 mmHg.** Sympathetic stimulation prolongs the plateau.	Bold including approximate range
	c. What are the proposed mechanisms involved in autoregulation? Prompt: What are some important metabolic changes that cause vasodilatation	**Myogenic: intrinsic contractile response of smooth muscle to stretch.** **Metabolic: production of vasodilator metabolites by active tissue**. Accumulation assoc. with decreased flow leads to vasodilation. Examples dec pO2, acidosis, high K, lactate, pCO2(brain and skin), local temp, adenosine (heart)	Both mechanisms & 2/5 metabolites
Question 2 Pulmonary resistance & Compliance LOA: 1	a. Describe the factors that determine the airway resistance in the lung. Prompt: when would airway resistance increase?	<u>Airway resistance</u> • Decreases with stimulation of ß-adrenergic receptors causing bronchodilatation. • Increases with parasympathetic nerve stimulation causing bronchoconstriction. • Increases with histamine • Increases when Lung volume reduces • Increases when pCO2 decrease • Increases with increase density & viscosity of gas	Need 3 factors to pass Poiseuille's Law: Resistance = 8 x viscosity x length / radius^4 x π
	b. With regard to lung **<u>compliance</u>** give examples of diseases that reduce compliance. Prompt define compliance: volume change/unit pressure.	b. Pulmonary fibrosis, pulmonary oedema, pulmonary haemorrhage, atelectasis, loss of surfactants such as respiratory distress syndrome.	Need 3 examples (may be others not listed that are acceptable)
Question 3 Renal H+ regulation LOA: 1	Describe the renal response to metabolic acidosis Prompts: "What prevents H+ secretion stopping when a pH of 4.5 is reached?" "What substances act as buffers in the urine?"	• **Renal compensation aims to normalise blood pH by reabsorbing all filtered HCO_3^-, and generating new HCO_3^-** by titration of filtered acid. • Anions that replace HCO_3^- are filtered at the glomerulus along with corresponding cations • **Renal tubule cells secrete H+ into tubular fluid** in exchange for Na^+ and HCO_3^- • **Buffering in the urine gives greater capacity to this system** (otherwise limiting pH of 4.5 would stop further H^+ elimination) Urinary buffers include **HCO_3^-**, PO_4^-, and NH3	Pass criteria **bold** Buffers need bold and 1 other

Question 4 Glucocorticoids LOA: 1	a. What are the physiological effects of glucocorticoids? Prompt: "Can you expand on non-vascular effects"	1. Essential for survival stress response 2. 'Permissive action' for **catecholamine effects: pressor/ vascular reactivity**, bronchodilation, calorigenesis, lipolysis **3. Metabolic**: protein catabolism, hepatic glycogenesis & gluconeogenesis. Rise in plasma glucose + peripheral anti-insulin effect. Increase plasma lipids. 4. Permit 'free water' excretion: plasma tonicity 5. Immunological: Decrease inflamm + allergic responses. Reduced lymphocytic activity, lymph tissue, cytokines 6. Haematological: increased neutrophils, RBC, platelets. Decreased basophils, eosinophils 7. Mental: EEG slowing, personality changes	**Must get bold, at least 2 metabolic + 1 other**
	b. How is glucocorticoid secretion regulated?	**Released adrenal cortex in response to ACTH from ant pituitary.** ACTH release driven by CRH from hypothalamus (response to low corticoid level or stress) **Glucocorticoid –ve feedback on hypothal/ pit to reduce ACTH secretion**	Must get **bold.**
Question 5 Hearing LOA: 2	a. What are the two major mechanisms of deafness?	**Conductive deafness** – due to impaired sound transmission in external or middle ear, affects all frequencies. **Sensorineural deafness** – due to loss of cochlear hair cells (commonest), or problems with CN VIII or within central auditory pathways, affects some frequencies.	**Bold** Explain both and 2 examples of each to pass
	b. Explain these causes in physiological terms and give examples.	**Examples** Conductive – blockage of extl canals (e.g. wax, FBs), otitis ext or media, perforated eardrum, osteosclerosis Sensorineural – degeneration (presbycusis), damage to outer hair cells (prolonged noise exposure), aminoglycoside antibiotics, CN VIII tumours or cerebellopontine angle, CVA in medulla.	
	Bonus: How can one differentiate between the two forms using a tuning fork?	Weber/ Rinne : 256 tuning fork	Bonus if have time

ACEM PRIMARY 2013/1 Physiology VIVA **Afternoon Session 2** ***Candidate Number:*** **AGREED MARK:**

TOPIC	QUESTIONS	KNOWLEDGE **(essential in bold)**	NOTES
Question 1: CORONARY BLOOD FLOW LOA: 1	a. Describe coronary arterial blood flow during the cardiac cycle. Prompts: How is flow different in the left and right coronary arteries during systole and diastole? Which part of the heart is most at risk due to low coronary flow?	**Greater flow in diastole c/w systole in L coronary** due to higher pressures required in the LV to overcome aortic pressure in systole. **LV subendocardium** most vulnerable as only gets diastolic flow. **R coronary flow throughout systole and diastole** due to lower RV pressures	Three main features to pass
	b. What factors can decrease coronary artery blood flow?	**1.Physiologic**: **Tachycardia:** shorter diastole; reduced L coronary flow in particular **2.Pathologic**: AS: Increased LV pressures req. to overcome stenosis & decreased flow; Vasospasm; Coronary artery disease; Heart failure: increased venous pressure; reduced coronary perfusion press.	Tachycardia and 2 pathological
Question 2 O2 transport LOA: 1	a. Describe how oxygen is carried in the blood.	**Dissolved**: amount dissolved proportional to partial pressure (Henry's law) – 0.3 ml O_2/100 ml blood/100 mm Hg PO_2 **Combine with haemoglobin**: 20.8 mg/100 ml blood.	Need **bold**
	b. Please draw the Oxyhaemoglobin dissociation curve.	See diagram: draw graph to pass, 3 key points (2/3 accurate): examples P50 & 90/60 and 1 other.	 Source: Levitzky MG: *Pulmonary Physiology*, 7th Edition: http://www.accessmedicine.com
	c. Describe factors that can affect the oxygen dissociation curve.	**Shift to right** by inc H^+ conc, pCO_2, temp, 2,3 diphosphoglycerate to unload oxygen. **Shift to left** with the opposite changes.	2 factors
Question 3 Renal Tubular Function LOA:	a. How do the ascending and descending limbs of the Loop of Henle differ in function?	Thin **descending limb water permeable** (aquaporins) and tubular **fluid becomes hypertonic**. **Thick ascending limb impermeable to water, and Na^+, K^+,Cl^- actively transported out, so fluid ends up more hypotonic.** K^+ diffuses back passively	Bold, illustrate clear difference
	b. Describe the process of tubuloglomerular feedback in the nephron.	This process **aims to maintain the constancy of the load delivered to the distal tubule**. The macula densa **in the ascending limb of the loop of Henle senses the rate of flow and feeds back to either increase or decrease the rate of filtration** in the glomerulus	Correct concept

Question 4 Anterior Pituitary Hormones including insufficiency LOA: 1	a. What hormones are secreted by the anterior pituitary? b. What are the clinical effects of anterior pituitary insufficiency?	**TSH; ACTH;** Growth hormone; LH; FSH; Prolactin 1. Adrenal cortical atrophy: glucocorticoid + sex hormone levels fall. Mineralocort secretion maintained: salt loss/ hypovolaemic shock does not occur. But unable to mount stress response. 2.Hypothyroidism; 3.Growth inhibition 4.Gonadal atrophy, sexual cycles cease, loss of some secondary sex characteristics 5.Tendency to hypoglycaemia (increased insulin sensitivity)	Bold + 2 other Pass: Adrenocortical effects + 2 other
Question 5 GIT handling of water and electrolytes LOA: 1	a. Explain the mechanisms of absorption of water and electrolytes in the gastrointestinal tract. Prompt: How is sodium absorbed? b. Explain the mechanisms of water and electrolyte secretion in the gastrointestinal tract. Prompt: How is chloride secreted?	**Absorption:** After meals – **fluid reuptake due to coupled transport of nutrients**, e.g. glucose and Na (Water reabsorbed 8800 ml) Between meals – NaCl enters across the apical membrane via the coupled activity of a Na/H exchanger and a Cl/HCO3 exchanger (electroneutral mechanism in small intestine & colon). In distal colon, Na enters the epithelial cell via epithelial Na Channels (electrogenic mechanism). **Secretion:** **Cl secretion occurs continuously in the small intestine & colon**. Cl uptake occurs via Na/K/2Cl co-transporter and is secreted into the lumen via Cl channels (CFTR = cystic fibrosis transmembrane conductance regulator). **Water endogenous secretions** 7000 ml	Bold and 1 mechanism of Na absorption somewhere Bold and 1 mechanism of Cl secretion somewhere Note: Water balance Input: Ingested 2000 ml & Endogenous secretions 7000 ml; Output: Reabsorbed 8800 ml; Balance in stools 200 ml

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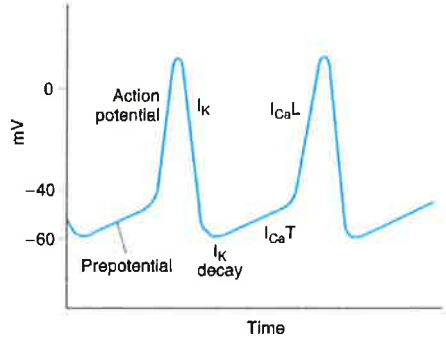
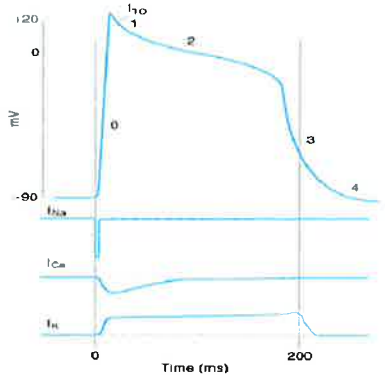
Question 1: LOA: 1 Cardiac Muscle Action Potential (- incl difference to pacemaker action potential)	a. Please draw and explain the action potential in a cardiac pacemaker cell. Prompt: "What electrolytes are responsible for each phase of the action potential?"	Pre-potential is initially due to a decrease in K^+ efflux, then completed by Ca^{2+} influx through CaT channels The action potential is due to influx of Ca^{2+} via CaL channels Repolarisation is due to K^+ efflux 	Must have the shape to pass and know the ion fluxes. 
	b. Describe the major differences between a ventricular muscle action potential and a pacemaker cell potential.	Greater negative RMP. Fast depolarisation via Na^+ versus slower Ca^{2+} dependent. No prepotential and no automaticity. Plateau phase.	Clear contrast to the above graph, No prepotential as no leaking Ca^{2+} and plateau due to Ca^{2+}.
Question 2 LOA: 1 Lung volumes and capacity	a. Please describe the components of total lung capacity? Prompt: What individual volumes or capacities are described in relation to the total lung capacity or volume.	**Tidal volume**: the volume of gas moved in and out of the lung during normal breathing (500ml) **Vital capacity**: the exhaled gas volume after a maximal inspiration (5.5-6 litres) **Residual volume:** the volume of gas remaining in the lung after maximal expiration (1.5-2 litres) **Functional residual capacity**: the volume of the gas in the lung after a normal expiration (3 litres)	Three of four volumes
	b. Name a method to measure each of these?	**Spirometer can measure tidal volume and vital capacity** Total lung capacity, functional residual capacity and residual volume may be measures by helium dilution or the body plethysmograph	Bold

Question 3 Renin- Angiotensin System LOA: 1	a. What are the actions of the renin-angiotensin system? b. What factors affect renin secretion?	**Mediated through AT II;** - arteriolar constriction with **rise in SBP and DBP; increases secretion of aldosterone;** facilitates release of NAd acting on post-ganglionic neurones; positive feedback loop on brain by decreasing sens. to baroreflex and increase effect of AT II, and secretion of vasopressin and ACTH **Stimulation: sympathetic activity** via renal nerves; increased circ. **Catecholamines;** prostaglandins **Inhibition: - increased Na and Cl reabsorption** across macula densa; **- increased afferent arteriolar pressure;** AT II; vasopressin	**Bold** **Bold**
Question 4 LOA: 1 Vasopressin (hypothalamus)	a. Describe the feedback loop that ensures homeostasis of blood osmolality b. Name the stimuli that affect vasopressin secretion	**increase blood osmolality** triggers: thirst mechanism; **renal conservation of water - via the release of vasopressin from the posterior pituitary** Both outcomes decrease blood osmolality back to normal. Feedback terminates hypothalamic signalling Increase: **increased osmotic pressure** plasma; **decreased ECF volume**; pain emotion stress exercise; nausea vomiting; standing; drugs (carbamezepine, clofibrate); angiotensin II Decrease: **decreased osmotic pressure** plasma; **increased ECF**; Alcohol	Bold to pass Bold & 2
Question 5 LOA: 1 Exocrine pancreas	a. List the enzymes secreted from the exocrine pancreas. b. Give at least 3 examples of substrates that these enzymes work on.	Trypsin – proteins,polypeptides Chymotrypsins– proteins,polypeptides Elastase –elastin and some proteins Carboxypeptidase A - proteins,polypeptides Carboxypeptidase B - proteins,polypeptides Colipase –fat droplets Pancreatic Lipase -triglycerides Bile salt –acid lipase –cholesterol esters Cholesterol ester hydrolase–cholesterol esters Pancreatic alpha amylase -starch Ribonuclease -RNA Deoxyribonuclease -DNA Phospholipase A2 –phospholipds	Lipase and at least 2 examples & matched substrates