**Markscheme: Physiology Data analysis and Essay Questions**

**1.** *Award* ***[1]*** *for every two of the following structures clearly drawn and labelled correctly.*
mouth;
esophagus;
stomach;
small intestine;
large intestine / colon;
anus;
rectum;
sphincters;
salivary glands;
liver;
pancreas;
gall bladder;

[4]

**2.** *(Award* ***[1]*** *for each of the following structures clearly drawn****and*** *labelled correctly.)*
lymph vessel;
arteriole;
venule;
(central) lacteal;
capillary network;
epithelial layer / lining / epithelium;
microvilli;
goblet cells;

[5]

**3.** (a) (i) 0.25 (± 0.05) mol dm–3 min–1 *(units needed)***or**
15.0 (±1.0) mol dm–3h–1 1

(ii) 215 (±15) min 1

(b) *β*-carotene and lycopene concentrations high initially;
*β*-carotene and lycopene concentrations decrease steadily /
all three decrease;
lutein concentration initially increases slightly;
lutein concentration relatively constant for first 120 minutes;
lutein concentration decreases after 120 minutes; 2 max

(c) removal of carotenoids by absorption in duodenum is
balanced by new additions from stomach;
cannot be broken down by small intestine
enzymes / no enzyme to digest lycopene;
higher pH stabilizes the compound /
acidic conditions of stomach favour its absorption while neutral /
basic conditions of the small intestine favour the reverse /
digested well in stomach but not in small intestine;
break down products of *β*-carotene and
lutein stabilize lycopene in small intestine; 1 max

[5]

**4.** (a) ileum epithelial cell membranes pump sodium ions out into lumen;
maintains concentration gradients;
passive re-entry of sodium ions is accompanied by nutrients;
such as glucose / amino acids;
which pass through epithelial cells;
and enter capillaries; 3 max

(b) hepatic artery from aorta brings blood to liver;
hepatic portal vein (from gut) brings blood to the liver;
incoming blood flows merge in sinusoids of liver;
sinusoids are liver capillaries;
sinusoids merge to form hepatic vein;
hepatic vein carries blood away from liver to vena cava; 3 max

(c) *Any two of the following*.
amino acids, urea, bilirubin,
globin, iron, haem 1

[7]

**5.** (a) *Two of the following needed for* ***[1]****.*
pancreatic;
salivary;
gastric pits / gastric glands;
glands in intestinal wall / krypts / Brunner’s gland;
liver 1 max

(b) erythrocytes rupture when they reach the end of their life span / after 120 days;
absorbed by phagocytosis / Kupffer cells in liver from blood;
hemoglobin split into globin and heme groups;
iron removed from heme leaving bile pigment / bilirubin;
bilirubin released into alimentary canal;
digestion of globin to produce amino acids; 4 max

[5]

**6.** (a) *Award* ***[1]*** *for any* ***two*** *of the following clearly drawn and correctly*
*labelled.*

right atrium;

left atrium;

right ventricle;

left ventricle;

semilunar valves;

atrioventricular valves;

pulmonary artery;

pulmonary vein;

vena cava (inferior / superior);

aorta;

chordinae tendinae / chords and septum;

relative wall thickness accurately drawn; 4 max

(b) the heart is myogenic / beats on its own accord;

60-80 times a minute (at rest);

coordination of heartbeat is under the control of pacemaker;

located in the muscle / walls;

sends out signal for contraction of heart muscle;

atria contract followed by ventricular contraction;

fibres / electrical impulses cause chambers to contract;

nerve from brain can cause heart rate to speed up;

nerve from brain can cause heart rate to slow down;

adrenalin (carried by blood) speeds up heart rate;

artificial pacemakers can control the heartbeat; 6 max

(c) *Answers must refer to all three vessels to achieve* ***[8 max].***

*arteries:* ***[3 max]***

thick muscle layers / elastic fibres to help pump blood;

thick collagen / fibres to avoid bursting / withstand high pressure;

narrow lumen relative to overall diameter;

narrow lumen to maintain pressure;

*veins:* ***[3 max]***

 thin muscle layers with few fibres because blood not under high
pressure;

thin so they are able to be pressed by muscles to pump blood;

wide lumen relative to overall diameter;

wide lumen to maintain blood flow / decrease resistance to flow;

contains valves to prevent backflow;

*capillaries:* ***[3 max]***

single layer of (thin) cells for diffusion;

pores between cells so phagocytes can squeeze out;

narrow lumen to fit into small spaces;

large number resulting in increased surface area; 8 max

*(Plus up to* ***[2]*** *for quality)*

[20]

**7.** (a) large total surface area;
wall of single layer of flattened cells;
moist lining;
walls elastic;
network of capillaries;
capillary walls are thin / one cell thick; 4 max

(b) *Each characteristic must be linked to a function for the mark to be awarded.
Arteries: Award* ***[3 max]***thick muscular wall to help pump blood / to help distribution of blood;
thick outer wall (of collagen and elastic fibres) to withstand high
pressure / to avoid bursting / leaks;
narrow lumen results in fast-moving blood;

 *veins: Award* ***[3 max]***thin outer muscular walls so no pumping action;
thin walls allow pressure from surrounding muscles to move blood;
thin walls (of collagen and elastic) as not likely to burst / low pressure;
wide lumen allows for slow-moving blood;
valves to prevent back flow / control direction of blood flow; 6 max

(c) cell respiration produces energy;
controlled release of energy;
by breakdown of organic molecules / glucose;
energy from them is used to make ATP;
aerobic respiration is in mitochondria;
requires oxygen;
pyruvate is produced by glycolysis / glucose broken down;
pyruvate is broken down in the mitochondria;
into carbon dioxide and water;
large production of ATP;
per molecule / mass of glucose;
much higher production of ATP than in anaerobic respiration; 8 max

[20)

**8.** (a) *Must have both for* ***[1]****.*
antigen is a substance / molecule that causes antibody formation;
antibody is a (globular) protein /
molecule that recognizes an antigen; 1

(b) antigen causes an immune response to produce antibodies
specific for that antigen;
antibodies produced in B-lymphocytes;
B-lymphocytes produced in bone marrow;
carried in blood;
antigen presenting cell /
helper T cell present antigen to B cell; 3 max

(c) *Must name two for* ***[1]****.*CO2;
O2;
hormones;
named nutrient;
urea / excess ions;
platelets;
bicarbonate; 1 max

[5]

**9.** (a) the skin / mucous membranes act as a physical barrier;
skin has several layers of tough / keratinized cells;
the skin is dry discouraging the growth and reproduction of pathogens;
skin / mucous membranes host natural flora and fauna which compete
with pathogens;
the enzyme lysozyme is present on the skin’s surface to break
down pathogens;
the pH of skin / mucous membranes is unfavourable to many pathogens;
skin is a continuous layer;
mucus traps pathogens / sticky; 3 max
*Award* ***[2 max]*** *if both skin and mucous membrane not mentioned.*

(b) antibiotics block metabolic pathways in bacteria / inhibit cell wall formation /
protein synthesis;
viruses use host cell metabolic pathways / do not possess a cell wall and so
are not affected by antibiotics;
antibiotics are not used to treat viral diseases because they are ineffective
and may harm helpful bacteria; 2 max
*No credit for answers that state antibiotic means against life nor for the statement that viruses are not alive.*

[5]

**10.** *Award* ***[1]*** *for each of the following structures clearly drawn and labelled*.
mouth / nose;
trachea;
bronchi;
bronchioles;
lungs;
alveoli;
diaphragm;
ribs / rib eye / intercostal muscles;

[5]

**11.** at high altitude there is a low partial pressure of O2 / less O2 in the air;
red blood cell production increases to increase O2 transport;
ventilation rate increase to increase gas exchange;
people living permanently at high altitude have greater lung surface area;
and larger vital capacity than people living at sea level;
muscles produce more myoglobin to encourage O2 to diffuse into muscles /
store O2 in muscles;
hemoglobin dissociation curve shifts to the right encouraging O2 release
into the tissues;

[3

**12.** pancreatic cells monitor blood glucose;
insulin / glucagon is a hormone;
low glucose level induces production of glucagon;
**-cells of pancreatic islet produce glucagon;
glucagon stimulates the liver to break glycogen into glucose;
glucagon leads to increase in blood glucose;
absorption of glucose from digestive tract causes glucose levels to rise (after meals);
high level of blood glucose induces production of insulin;
**-cells of pancreatic islet produce insulin;
insulin stimulates uptake of glucose into cells (muscles);
insulin stimulates uptake of glucose into liver / storage of glucose as glycogen in liver;
insulin leads to decrease in blood glucose;
homeostatic monitoring of blood glucose levels is constantly happening;
skipping meals can cause blood glucose levels to drop;
in diabetes mellitus blood insulin low / target cells insensitive;
blood glucose regulation is an example of negative feedback;
adrenaline leads to increased blood glucose levels; 8 max

 *(Plus up to* ***[2]*** *for quality)*

[8]

**13.** produced in hypothalamus;
via neurosecretory cells;
passes from hypothalamus to pituitary;
attached to carrier protein / neurophysin;
(stored) in posterior pituitary / neurohypophysis;
released under stimulus by osmoreceptors in hypothalamus;
osmoreceptors stimulated by high blood plasma concentration / reduced
blood pressure;

 increases water reabsorption (in kidneys);
site of action is collecting duct;
promotes constriction of blood vessels;
increases blood pressure;
there is a negative feedback control of ADH secretion;
*Only* ***[2 max]*** *can be awarded in relation to the last four points.
Accept reference to vasopressin instead of ADH.*

[6]

**14.** (a) *For a diagram of a nephron, award* ***[1]*** *for every two of the following
structures clearly drawn and correctly labelled.*

 glomerulus;
Bowman’s capsule;
proximal convoluted tubule;
loop of Henle;
ascending and descending both labeled;
distal convoluted tubule;
collecting duct;
afferent arteriole / efferent arteriole; 3 max

(b) difference in diameter of efferent and afferent arteriole;
leads to blood in glomerulus at high pressure;
capillary wall is fenestrated / has pores / holes;
basement membrane has pores;
pores in basement membrane prevent large (protein)
molecules from leaving blood plasma /
only allows passage of small molecules;
passive process; 3 max

(c) (large) proteins in blood plasma but not in glomerular filtrate;
all other substances equal in concentration; 2

[8]

**15.** (a) 5.3 ( 0.3) pmol dm–3 (unit needed) 1

(b) a positive correlation;
no data below 280 mOsmol kg–1; 1 max

(c) after drinking water, blood plasma / solute concentration decreases;
plasma ADH concentration decreases;
osmoreceptors in the hypothalamus monitor blood solute / blood plasma /
plasma concentration;
impulses passed to ADH neurosecretory cells to reduce / limit release of ADH;
drop in ADH decreases the effect of this hormone on the kidneys;
blood solute concentration returns to normal; 2 max

(d) vomiting / diarrhoea / blood loss;
increase salt intake;
drink alcohol / coffee;
certain drugs / morphine / nicotine / barbiturates;
excess sweating / lack of water intake;
diabetes as it increases glucose in blood; 2 max

[6]

**16.** both involve meiosis;
both involve cell proliferation / mitosis (before meiosis);
both involve cell growth / enlargement (before meiosis);
LH / FSH involved in both;
testes versus ovaries;
spermatogenesis starts at puberty versus oogenesis
starts in the fetus;
spermatogenesis until death versus oogenesis until menopause;
spermatogenesis continuously versus oogenesis in a cycle;
millions of sperm daily versus one egg per month;
ejaculation of sperm any time versus ovulation in middle
of menstrual cycle;
four sperm per meiosis / spermatogonium versus one
egg per meiosis / oogonium;
spermatogenesis involves equal divisions versus oogenesis
involves unequal cell / cytoplasm divisions;
no polar bodies in spermatogenesis versus 2 or 3 polar
bodies in oogenesis;
spermatogenesis involves Sertoli /
nurse cells versus oogenesis does not;
meiosis II completed before fertilization in spermatogenesis
versus after in oogenesis;
testosterone needed for spermatogenesis versus
not needed for oogenesis;

[7]

**17.** FSH stimulates the development of follicles;
FSH stimulates estrogen secretion (by the developing follicle);
estrogen stimulates the repair of the uterus lining;
estrogen stimulates LH secretion;
LH causes ovulation;
LH causes the development of the corpus luteum;
LH causes secretion of progesterone;
progesterone causes thickening of the uterus lining / prepares uterine
lining for implantation;
progesterone / estrogen inhibits the secretion of LH / FSH;
falling progesterone levels at the end of the cycle allow FSH production / menstruation;
feedback control; 8 max
*(Plus up to* ***[2]*** *for quality)*

[8]

**18.** motor neurones carry impulses / messages to muscle;
nerves / neurones stimulate muscles to contract;
neurones control the timing of muscle contraction;
muscles provide the force for / cause movement;
muscles are attached to bone by tendons;
bones act as levers;
joints between bones control the range of movement;
antagonistic muscles cause opposite movements; 6 max

 *(Plus up to* ***[2]*** *for quality)*

[6]

**19.** neurotransmitters released by pre-synaptic neurons;
diffuse across synapse;
bind to specific receptors on post-synaptic membranes;
some neurotransmitters increase permeability of post-synaptic
membrane to positive ions;
causing localized depolarization;
which helps an action potential to form / raises membrane above threshold;
*eg* acetylcholine or other example;
others cause negatively charged chloride ions to move across post-synaptic
membrane into the cell / K+ moves out of the post-synaptic nerve cell;
*eg* GABA / other example;
leading to hyper-polarization;
which inhibits action potentials; [6]

**20.** muscles / fibres / myofibrils contain (repeating) units called sarcomeres;
muscle / sarcomeres contain actin filaments and myosin filaments;
actin fibres are thin and myosin fibres are thick;
arriving action potential causes release of Ca2+;
from sarcoplasmic / endoplasmic reticulum;
Ca2+ binds to troponin;
causing troponin and tropomyosin to move (on actin);
exposing binding sites on actin / for myosin;
ATP binds to myosin heads releasing them / breaking cross bridges;
ATP hydrolysed / split into ADP + Pi;
ATP / energy causes myosin heads to change shape / swivel / become cocked;
myosin heads bind / form cross-bridges to (exposed) actin binding sites;
myosin heads swivel / move actin (releasing ADP + Pi);
myosin filaments move actin filaments towards centre of sarcomere;
sliding of filaments / actin and myosin shortens the sarcomere; 9 max
*(Plus up to* ***[2]*** *for quality)* [9]