**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]