Chapter 6 Extended response *[501 marks]*

1a. Draw a labelled diagram of a motor neuron. *[5 marks]*

Markscheme

*Award **[1]** for each of the following clearly drawn and correctly labelled.*

a. cell body – shown with a nucleus;

b. nucleus correctly labelled;

c. axon – shown as double line longer than the longest dendrite;

d. myelin sheath/Schwann cells – surrounding the axon;

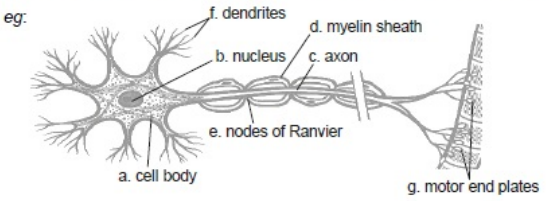
e. nodes of Ranvier – shown in axon;

f. dendrites – shown extending from the cell body;

g. motor end plates – not covered by myelin sheath and ending with buttons/dots;

Award any of the above marking points to clearly drawn annotated diagram.

eg:



1b. Explain how an impulse passes along the membrane of a neuron. *[8 marks]*

Markscheme

a. resting potential is –70mV / relatively negative inside in comparison to the outside;

b. $Na^{+/}K^{+}$ pumps maintain/re-establish (the resting potential);

c. more sodium ions outside than inside (when at the resting potential);

d. more potassium ions inside than outside (when at the resting potential);

e. nerve impulse is an action potential that stimulates a (wave of) depolarization along the membrane/axon;

f. if neuron is stimulated/threshold potential/–50mV is reached sodium ion channels open;

g. sodium ions diffuse/move in;

h. (Na^{+} move in) causing depolarization;

i. potassium ion channels open / potassium ions diffuse/move out;

j. (K^{+} move out) causing repolarization;

k. local currents / description of Na^{+} ion diffusion between depolarized region and next region of axon to depolarize;

Accept any of the above points clearly explained in an annotated diagram.

1c. Describe the process of endocytosis. *[5 marks]*

Markscheme

a. (plasma) membrane encloses/engulfs solid particles/droplets of fluid/molecules;

b. fluidity of the membrane allows endocytosis;

c. (plasma) membrane forms pit/forms indentation/pulled inwards/invaginates;

d. membrane pinches off /seals back on itself/edges fuse;

e. vesicle/vacuole formed;

f. inside of plasma membrane becomes outside of vesicle membrane / converse;

g. vesicle breaks away from plasma membrane/moves into cytoplasm;

h. active process / endocytosis/vesicle formation requires energy;

Accept any of the above points clearly described in an annotated diagram.

2a. Draw a labelled diagram to show the structure of a sarcomere. *[5 marks]*

Markscheme

*Award **[1]** for each structure clearly drawn and correctly labelled.*

a. sarcomere – clearly indicated between Z lines (whether Z lines named or not);

b. Z lines – shown at the ends of a sarcomere;

c. actin (filaments) – drawn as thin lines attached to Z lines;

d. myosin (filaments) – drawn as thick lines interdigitating with thin/actin filaments;

e. myosin heads – on both sides of at least one myosin filament;

f. light band and dark band – indicating regions of actin only and myosin plus actin;

2b. Explain how an impulse passes along the axon of a neuron. *[8 marks]*

Markscheme

a. resting potential is –70mV / relatively negative inside in comparison to the outside;

b. Na^+/K^+ pumps maintain/re-establish (the resting potential);

c. more sodium ions outside than inside (when at the resting potential);

d. more potassium ions inside than outside (when at the resting potential);

e. nerve impulse is an action potential that stimulates a (wave of) depolarization along the membrane/axon;

f. if neuron is stimulated/threshold potential/–50mV is reached sodium ion channels open;

g. sodium ions diffuse/move in;

h. (Na^+ move in) causing depolarization;

i. potassium ion channels open / potassium ions diffuse/move out;

j. (K^+ move out) causing repolarization;

k. local currents / description of Na^+ ion diffusion between depolarized region and next region of axon to depolarize;

Accept any of the above points clearly explained in an annotated diagram.

2c. Describe the process of endocytosis. *[5 marks]*

Markscheme

a. (plasma) membrane encloses/engulfs solid particles/droplets of fluid/molecules;

b. fluidity of the membrane allows endocytosis;

c. plasma membrane forms pit/forms indentation/pulled inwards/invaginates;

d. membrane pinches off/seals back on itself/edges fuse;

e. vesicle/vacuole formed;

f. inside of plasma membrane becomes outside of vesicle membrane / converse;

g. vesicle breaks away from plasma membrane/moves into cytoplasm;

h. active process / endocytosis/vesicle formation requires energy;

Accept any of the above points clearly described in an annotated diagram.

3a. Draw a labelled diagram to show the structure of the heart. *[5 marks]*

Markscheme

*Award **[1]** for each of the following structures clearly drawn and labelled correctly in a diagram of the heart.*

a. left ventricle/right ventricle – both left and right ventricles must be shown but the mark can be awarded if either is correctly labelled. The left must be thicker walled than right and both must be larger than the atria;

b. left atrium/right atrium – both left and right atria must be shown with thinner walls than ventricles, but the mark can be awarded if either atrium is correctly labelled;

c. atrio-ventricular valves/tricuspid and bicuspid valves – positioned between atria and ventricles, with both labelled and tri/bicuspid correct if these names are used;

d. semi-lunar valves –shown at the start of the aorta and pulmonary artery, with the cusps facing in the right direction;

*Award **[1]** for any two blood vessels clearly drawn and correctly labelled.*

aorta – shown connected to the left ventricle;

pulmonary artery – shown connected to the right ventricle;

pulmonary vein – shown connected to the left atrium;

vena cava – shown connected to the right atrium;

3b. Outline how the human body responds to high blood glucose levels. *[5 marks]*

Markscheme

a. (high blood glucose levels) detected by pancreas islet cells/beta cells;

b. insulin secreted in response (to high blood glucose/glucose above threshold level);

c. insulin stimulates cells to absorb glucose;

d. glucose used in cell respiration (rather than lipids);

e. glucose converted to glycogen (in liver/muscle cells);

f. glucose converted to fatty acids/triglycerides/fat;

g. negative feedback process;

3c. Explain the role of the nephron in maintaining the water balance of the blood in the human body. *[8 marks]*

Markscheme

a. ultrafiltration in the glomerulus produces (large volumes of) filtrate;

b. 80%/most of water in filtrate is (always) (re)absorbed in proximal convoluted tubule;

c. water reabsorbed from filtrate in descending loop of Henle;

d. pituitary gland secretes ADH if blood solute concentration is too high;

e. ADH makes the collecting duct/distal convoluted tubule more permeable to water;

f. ADH moves aquaporins into the membranes (of cells in the tubule wall);

g. more water reabsorbed from filtrate/into blood due to ADH;

h. blood becomes more dilute / small volume of urine with high solute concentration;

i. with low/no ADH less water is reabsorbed in the collecting duct;

j. blood becomes more concentrated / large volume of dilute urine;

k. water reabsorption in collecting duct due to high solute concentration of medulla;

l. active transport of Na^+ ions from filtrate in ascending limb of loop of Henle;

4a. Draw a labelled diagram of the human heart showing the attached blood vessels. *[6 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

NB: *Drawings must be correctly proportioned and clearly drawn showing connections between structures. The drawing may show the heart without contraction or in any stage of contraction. Award [1] for any correctly labelled part that has been drawn to the stated standards.*
a. atria/right atrium/left atrium – *shown above the ventricles and must not be bigger than ventricles*;
b. ventricle/left ventricle/right ventricle – *shown below the atria, must have thicker walls than atria*;
c. vena cava/superior vena cave/inferior vena cava – *connected to right atrium*;
d. pulmonary artery – *shown from right ventricle (to lungs);*
e. pulmonary vein(s) – *shown (from lungs) to left atrium*;
f. aorta – *shown as large artery from left ventricle out of heart*;
g. AV valves/atrioventricular valves / mitral/bicuspid and tricuspid – *named correctly and shown between both atria and ventricles and labelled at least on one side*;
h. semilunar valves – *shown in aorta/pulmonary artery*;
Valves need to open in correct direction.

4b. Describe the action of the heart in pumping blood. *[5 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. (both) atria collect blood (from veins);
b. sinoatrial/SA node sends impulses to muscle/fibres initiating contraction;
c. blood is pushed to ventricles by contraction of atria/atrial systole;
d. AV (atrioventricular) valves are open (as atria contract);
e. semilunar valves are closed so that ventricles fill with blood;
f. ventricles contract / ventricular systole;
g. AV (atrioventricular) valves close (and preventing backflow);
h. blood is pushed out through the semilunar valves/into pulmonary artery and aorta;
i. when ventricles relax/diastole, semilunar valves close preventing backflow of blood;
Do not accept the description of blood flow without a clear action.
Do not accept general statements such as systole = heart contraction and diastole = heart relaxation.

[4 max] *if suggests that left and right sides are contracting at different times or simultaneous contraction not indicated.*

4c. Nerves connecting the brain and heart contain neurons that control heart rate. Explain how a nerve message passes from one neuron to another neuron. *[7 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. nerve impulse reaches the end of the presynaptic neuron;
b. (depolarization causes) calcium channels in membrane (to) open;
c. calcium diffuses into the presynaptic neuron;
d. vesicles of/containing neurotransmitter move to and fuse with presynaptic membrane;
e. (neurotransmitter) released (by exocytosis) into synaptic space/cleft;
f. (neurotransmitter) diffuses across the space/synapse;
g. (neurotransmitter) attaches to receptors on postsynaptic neuron;
h. receptors cause ion channels to open and sodium diffuses into the postsynaptic neuron;
i. the postsynaptic neuron membrane is depolarized;
j. (depolarization) causes a new action potential;
k. (neurotransmitter) on postsynaptic membrane is broken down;
l. (neurotransmitter) is reabsorbed into the presynaptic neuron;

5a. Explain how skeletal muscle contracts. *[8 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. sliding filament model / filaments/actin and myosin slide past each other;
b. action potential/depolarisation/nerve impulse arrives at end of motor neurone;
c. neurotransmitter/acetylcholine released causing action potential (in muscle fibre);
d. sarcoplasmic reticulum releases calcium ions;
e. calcium ions cause binding sites on actin/for myosin to be exposed;
f. myosin heads bind to sites on actin/form cross-bridges;
g. myosin (head) moves actin filament using energy from ATP;
h. actin moved towards the centre of sarcomere/M line/M band;
i. sarcomeres shortened;
j. (binding of) ATP causes release of myosin head from actin;
k. conversion of ATP to ADP and Pi causes myosin heads to change angle;
l. cycle (of events) repeated (during muscle contraction);
Accept the above points in annotated diagrams.

5b. Active skeletal muscle requires a good supply of oxygen. Outline the mechanism of ventilation in the lungs. *[6 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

during inhalation:
a. external intercostal muscles contract moving rib cage up and out;
b. diaphragm contracts becoming lower/flatter;
c. increase in volume and decrease in pressure (of thorax);
d. air flows into lungs as atmospheric pressure is higher;

during exhalation:
e. internal intercostal muscles contract so ribs move in and down;
f. diaphragm relaxes and returns to domed shape;
g. decrease in volume and (therefore) increase in pressure (of thorax);
h. air moves out until pressure in lungs falls/is equal to atmospheric pressure;
i. abdominal muscles can be used to make a stronger/forced exhalation;

6a. All organisms take in and also release carbon compounds. Draw a labelled diagram of the carbon cycle. *[5 marks]*

Markscheme

CO_2 in atmosphere/air;
plants/producers linked to carbon in air/CO_2 with arrow labeled photosynthesis;
plants/consumers linked to animals/consumers with arrow labeled feeding;
plants/producers and animals/consumers linked to carbon in air/CO_2 with arrow labeled (cell) respiration;
plants/producers and animals/consumers linked to decomposers/bacteria/fungi with arrow labeled death;
decomposers/bacteria/fungi linked to carbon in air/CO_2 with arrow labeled (cell) respiration;
plants/producers connected to carbon in air/CO_2 with arrow labeled combustion/forest fire;
decomposers/bacteria/fungi linked to fossil fuels/coal/oil/natural gas with arrow labeled (partial) decomposition;
fossil fuels/coal/oil/gas linked to carbon in air/CO_2 with arrow labeled
combustion;

Award marking points only if arrows point in correct direction.

6b. Describe how the rate of photosynthesis can be measured. *[6 marks]*

Markscheme

correct equation for photosynthesis in words or symbols;
measure production of oxygen;
example of method to measure oxygen production;
(eg count bubbles from water plant/collect oxygen data per unit of time using electronic sensors/probes)
measure uptake of CO_2;
example of method; *(eg method of measuring (aquatic) pH changes/shift per unit time)*
measure increase in biomass;
example of method; *(eg sample (dry) mass of crop before and after timed period)*

not possible to measure water uptake since water is transpired/used in turgidity/many chemical processes;
another valid method if concept of rate (measurements per time) is included;

6c. Explain the mechanism of ventilation in humans. *[7 marks]*

Markscheme

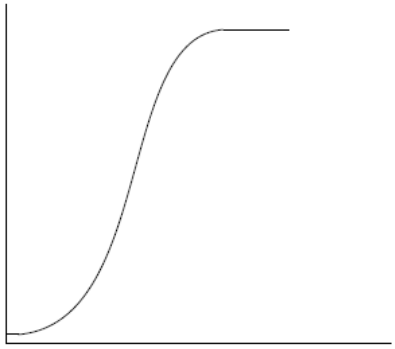
air enters/exits lungs through trachea, bronchi and bronchioles;
during inspiration/inhalation external intercostal muscles contract;
causing ribs to move upwards/outwards;
during inspiration diaphragm contracts/flattens;
causes increase in volume of thorax/lungs;
decrease in pressure allows air to enter (passively);
during expiration internal intercostal muscles contract/external intercostal muscles relax;
causing ribs to move down/in;
diaphragm relaxes/returns to original domed position;
abdominal muscles contract to push diaphragm up;
causes decrease in volume of thorax/lungs;
increase in pressure forces air out of lungs;
Award [5 max] for inhalation or exhalation only.

(Plus up to [2] for quality)

7a. Reproduction can cause populations to increase rapidly. Draw a labelled graph showing a sigmoid population growth curve. *[4 marks]*

Markscheme

(a)



S-shaped curve correctly drawn; } *(eg does not fold back on itself)*

y-axis labelled as population/number of individuals and *x*-axis labeled as time/ years etc; } *(both axes must be correctly labelled)*

exponential/log growth indicated at point where rate is increasing;
transitional phase indicated at point where rate is decreasing;
plateau phase; *Do not accept carrying capacity* ***[4 max]***

7b. Explain the various possible consequences of overproduction of offspring. *[6 marks]*

Markscheme

overpopulation/overproducing (of offspring) leads to competition for limited resources/struggle for survival;

example of limited resource; *(eg water/space/food)*

not all can survive / less adapted will die/migrate;

some varieties/individuals more suited for environmental conditions;

they are more likely to survive and reproduce;

this is natural selection;

increase chances/spread of disease in population;

waste products of the population may reach toxic levels;

may exceed carrying capacity leading to population crash;
Do not accept references between species.

7c. Outline the role of hormones in the menstrual cycle. *[8 marks]*

Markscheme

FSH (released from pituitary) stimulates follicle growth (in ovary);
oocytes/egg cells mature;
cells of growing follicle produce estrogen;
estrogen signals endometrium/lining of uterus to thicken;
causes final maturation of follicle;
high levels of estrogen stimulate secretion of LH;
LH spike stimulates ovulation/follicle ruptures releasing oocyte/ova/egg cells;
LH stimulates follicle (left behind in ovary) to develop into corpus luteum;
LH stimulates corpus luteum to secrete progesterone/estrogen;
progesterone/estrogen stimulates continued development/maintenance of lining of uterus (in preparation for implantation of embryo);
if no pregnancy then corpus luteum disintegrates;
drop in progesterone/estrogen hormone levels causes breakdown in uterine lining/menstruation;
progesterone/estrogen inhibit FSH/LH release;
(Plus up to [2] for quality)

8a. Draw a labelled diagram to show the molecular structure of a membrane. *[4 marks]*

Markscheme

Award [1] for each of the following clearly drawn and correctly labelled.

phospholipid bilayer; *(double row of opposing phospholipids, tails to inside)*

hydrophilic/phosphate/polar (heads) and hydrophobic/hydrocarbon/fatty acid/nonpolar (tails) labeled;

integral protein; *(embedded in the phospholipid bilayer)*

protein channel/channel protein; *(integral protein showing clear channel/pore)*

peripheral protein; *(shown on surface or slightly embedded on either side)*

glycoprotein*; (with carbohydrate attached on outer side)*

cholesterol; *(shown embedded in bilayer and smaller than the hydrophobic tail)*

8b. Some proteins in membranes act as enzymes. Outline enzyme-substrate specificity. *[6 marks]*

Markscheme

enzyme shape is specific to (particular) substrate;
lock and key analogy/model;
example of specific enzyme and substrate;
has specific 3-D/tertiary configuration/3-D/tertiary shape essential to functioning;
active site on enzyme binds to substrate;
substrate and active site complementary/fit together;
(substrate and active site) are complementary due to structure/chemical attraction;
enzyme-substrate complex forms;
denaturation changes enzyme's binding ability (to specific substrate);
Award [6] for the above points clearly shown in an annotated diagram.

8c. Membranes of pre-synaptic and post-synaptic neurons play an important role in transmission of nerve impulses. Explain the principles of synaptic transmission. *[8 marks]*

Markscheme

synapse is gap between adjacent neurons;
(arriving) action potential depolarizes pre-synaptic membrane;
opens (voltage-gated) calcium channels in membrane;
causes influx of calcium ions;
causes synaptic vesicles to fuse with pre-synaptic membrane;
vesicles release/exocytose neurotransmitter into the synaptic cleft;
neurotransmitter diffuses/moves across synaptic cleft;
neurotransmitter binds to receptors on post-synaptic membrane;
opens channels allowing sodium ions/potassium ions to diffuse;
initiation of action potential/depolarization in post-synaptic membrane;
removal/breakdown of neurotransmitter stops effect on post-synaptic membrane;
Award any of the above points for a clearly drawn correctly annotated diagram.
(Plus up to [2] for quality)

9a. Describe the properties of water that make it a useful component of blood. *[4 marks]*

Markscheme

a. water is a polar molecule / hydrogen bonding;
b. (makes it) (versatile) solvent;
c. example of dissolved substance (eg salts/proteins or other example);
d. (water is) fluid/liquid at body temperature;
e. example of transported material (eg nutrients/metabolic wastes/gases/hormones/blood cells or other example);
f. high heat capacity/specific heat allows water to carry heat without warming up;
g. (allows) blood to move heat (for warming/cooling/homeostasis);

9b. Explain the relationship between structure and function of arteries, capillaries and veins. *[8 marks]*

Markscheme

Arteries: **[3 max]**
a. thick walls to withstand high pressure/maintain blood flow/pressure;
b. collagen fibres/elastic fibres/connective tissue (in outer layer) give wall strength/flexibility/ability to stretch and recoil;
c. (smooth) muscle layer (contracts) to maintain pressure;
d. narrow lumen maintains high pressure;
e. smooth endothelium for efficient transport/reduced friction;

Capillaries: **[3 max]**
f. wall has one layer of cells allowing (fast) diffusion of substances;
g. pores to allow lymphocytes/plasma to exit / to increase permeability;
h. extensive branching increases surface area for exchange of materials;
i. small diameter allows them to fit between cells/perfuse tissue;
j. narrow diameter increases oxygen diffusion from RBC;

Veins: **[3 max]**
k. thin walls allow (skeletal) muscles to exert pressure on veins;
l. thin outer layer of collagen/elastic/muscle fibres provide structural support;
m. wide lumen allows great volume of blood to pass;
n. valves prevent backflow;
NB *Every structure requires a function for the mark.*

9c. Outline how leucocytes defend the body against pathogens. *[6 marks]*

Markscheme

a. leucocytes/phagocytes/macrophages can recognize pathogens/foreign matter;
b. (phagocytes) engulf pathogens by endocytosis/phagocytosis;
c. migration to tissues/squeezing out of capillaries;
d. each pathogen has specific antigens;
e. leukocytes/lymphocytes produce antibodies by reacting to specific antigen/ pathogens;
f. antibody joins to (specific) antigen inactivating/destroying them;
g. lymphocyte makes a clone/copies itself;
h. thus increasing the total number of (specific) antibodies;

10a. State the functions of the following organelles of a eukaryotic animal cell: lysosome, Golgi apparatus, free ribosomes, plasma membrane, rough endoplasmic reticulum. *[5 marks]*

Markscheme

lysosome:
a. (from Golgi apparatus) with digestive enzymes / break down food/organelles/ cell;

Golgi apparatus:
b. site that processes/modifies/packages and releases proteins;

free ribosomes:
c. site of synthesis of proteins (released to cytoplasm);

plasma membrane:
d. controls entry and exit of materials/substances in cell;

rough endoplasmic reticulum:
e. synthesis and transport of proteins; (*both needed*)

10b. Distinguish between anaerobic and aerobic cell respiration in eukaryotes. *[4 marks]*

Markscheme

	aerobic	anaerobic
a.	requires oxygen	no oxygen;
b.	(in cytoplasm and) mitochondria	in cytoplasm;
c.	Krebs cycle	no Krebs cycle;
d.	large yield of ATP/energy	small yield of ATP;
e.	CO_2 and water *(both needed)*	lactate (animals);
f.		ethanol + CO_2 (yeast/plants); *(both needed)*

*Award **[1]** for each contrasting characteristic.*

Table format is not necessary for the marks.

10c. Explain the mechanism of ventilation in the lungs in order to promote gas exchange for cell respiration. *[9 marks]*

Markscheme

a. inspiration/inhalation brings air into lungs;
b. external intercostal muscles contract;
c. and move rib cage upwards and outwards;
d. diaphragm flattens/contracts;
e. increasing thoracic volume;
f. pressure decreases from atmospheric pressure so air rushes into lungs;
g. expiration/exhalation forces air out;
h. internal intercostal muscles contract / external intercostal muscles and diaphragm relax;
i. abdominal/abdomen wall muscles contract and push diaphragm upwards;
j. decreasing thoracic volume;
k. increasing pressure in lungs so air is forced out;
l. a concentration gradient between air sacs and blood needs to be maintained;

11a. Describe the process of blood clotting. *[4 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. clotting factor released by platelets/damaged tissue/cells;
b. cascade/series of reactions;
c. prothrombin (activated) to thrombin;
d. soluble fibrinogen to insoluble fibrin / thrombin converts fibrinogen to fibrin;
e. mesh of fibrin/fibres seals wound/traps platelets/red blood cells;

11b. Factor IX is a blood clotting protein which some hemophiliacs lack. In the future hemophilia could be treated using clotting factors synthesized by genetically modified bacteria. Outline the basic technique used for this gene transfer. *[6 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. mRNA/gene coding for factor IX extracted from human cell/tissue;
b. mRNA copied to DNA/cDNA (using reverse transcriptase);
c. plasmids used (for gene transfer);
d. restriction enzyme/endonuclease used to open plasmid/cut DNA;
e. complementary bases/sticky ends on gene and plasmid/link gene to plasmid;
f. sealed using ligase;
g. recombinant plasmid/plasmid containing desired gene taken up by bacteria;
h. isolate/clone the recombinant/transformed bacteria;
i. bacteria cultured/grown in fermenter to produce factor IX;

11c. Explain how males inherit hemophilia and how females can become carriers for the condition. *[8 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. hemophilia is due to a recessive allele/is a recessive trait / X^H is normal allele and X^h is hemophilia allele;
b. hemophilia is sex linked;
c. allele/gene is on the X chromosome;
Reject disease/hemophilia carried on X chromosome.
d. (sex chromosomes in) females are XX while males are XY;

e. Y chromosomes do not have the allele/hemophiliac males are X^hY;
f. males inherit their X chromosome from their mother/do not pass the allele to sons;
g. males have only one copy so recessive trait/allele is not masked;
h. males have a 50% chance of hemophilia/receiving the allele if mother is a carrier;

i. carrier is heterozygous for the gene/is X^HX^h;
j. dominant/normal allele masks the recessive allele (so clotting is normal);
k. females inherit one X chromosome from father and one from mother;
l. affected/hemophiliac males have carrier daughters;
m. hemophilia allele could have been inherited from either parent;

Accept the points above explained either in text or clearly using a Punnett grid or genetic diagram, but not for simply reproducing an unlabeled Punnett grid or diagram without explanation.

12a. Draw a labelled diagram of a mitochondrion as seen in an electron micrograph. *[4 marks]*

Markscheme

*Award **[1]** for each one of the following labelled structures.*
a. outer membrane and inner membrane shown as two separate lines;
b. inter-membrane space / space between inner and outer membranes;
c. cristae (shown as projections of inner membrane);
d. matrix;
e. (70S) ribosomes (shown as dots in the matrix);

12b. A supply of oxygen is needed for aerobic respiration in mitochondria. Describe the features of alveoli in human lungs that adapt them for efficient absorption of oxygen. *[6 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

a. large surface area from having many alveoli;
b. single/flattened layer of (thin) cells in wall;
Reject one-cell membrane/thin membrane.
c. (surrounded by) dense network of capillaries/capillary bed;
d. short distance for gases/oxygen/carbon dioxide to diffuse;
e. moist lining / film of moisture on inside of alveolus;
f. moisture allows oxygen/gases to dissolve;
g. diffusion of oxygen down concentration gradient;

12c. Explain the mechanism of ventilation of human lungs. *[8 marks]*

Markscheme

Remember, up to TWO "quality of construction" marks per essay.

Award these points either for inspiration or expiration but not both:
a. ventilation is movement of air into and out of lungs;
b. volume of thorax/lungs/chest increased/decreased;
c. pressure in thorax/lungs/chest decreased/increased;
d. air flows from higher to lower pressure / air flows until the pressures are equal;

During inspiration/inhalation:
e. external intercostal muscles contract so ribcage moved up/out;
f. diaphragm contracts so moves down/becomes flatter;
g. internal intercostal/abdomen (wall) muscles relax;

During expiration/exhalation:
h. external intercostal muscles relax so ribcage moved down/in;
i. diaphragm relaxes;
j. recoil of elastic fibres that stretched during inspiration;
k. internal intercostal muscles contract (during forced ventilation);
l. abdomen (wall) muscles contract (during forced ventilation);

13a. Outline how and where energy is stored in plants. *[4 marks]*

Markscheme

a. glucose (from photosynthesis) stored as starch;
b. starch stored (as granules) in chloroplast/in plastids;
c. (starch stored) in seeds/storage roots/stem tubers;
d. stored as lipids/oils;
e. (lipid/oils storage) in seeds;
f. lipids store twice as much energy per gram as starch;

13b. Ecologists sometimes display data from an ecosystem using a diagram called a pyramid of energy. Describe what is shown in pyramids of energy. *[6 marks]*

Markscheme

a. pyramid of energy shows the flow of energy from one trophic level to the next (in a community);
b. units of pyramids of energy are energy per unit area per unit time/kJ m^{-2} yr^{-1};
c. bar width is proportional to the energy stored (in the biomass) in that trophic level;
d. the first/lowest trophic level is producers;
e. second level is primary consumers/herbivores;
f. third level of secondary consumers/carnivores;
g. only a small amount (10 to 20 %) of energy of one level is passed to the next;
h. bar width/energy stored in the trophic level decreases (proportionally) as you go up each level;
i. pyramid shows that there is a limit to the length of food chains;
Award any of the above marking points to a correctly drawn and clearly labelled pyramid.

13c. Explain the control of body temperature in humans. *[8 marks]*

Markscheme

a. normal body core temperature constant/36.5 to 37.5°C; (*accept single values within this range*)
b. regulated by negative feedback/homeostatic mechanisms;
c. hypothalamus is the centre of thermoregulation;
d. hypothalamus sends impulses to the body to increase/decrease temperatures;
e. release of sweat (by sweat glands in the skin) if skin temperature rises;
f. evaporation of water cools the body; (*concept of evaporation must be mentioned*)
g. heat is transferred by blood;
h. transfer of heat from body core in blood to surface;
i. if temperature rises, increased flow of blood/heat to the skin/vasodilation of skin blood vessels/arterioles; (*do not accept veins, arteries or capillaries*)
j. if temperature drops, decreased flow of blood/heat to the skin/vasoconstriction of skin blood vessels/arterioles; (*do not accept veins, arteries or capillaries*)
k. shivering increases heat production (in muscles);
l. example of one behavioural mechanism; (*eg reducing activity (to lower body temperature) / reducing exposed surfaces (to reduce heat loss*)

14a. Describe **four** different types of transport of substances across a membrane. *[4 marks]*

Markscheme

Must be description of types not a list.
a. (simple) diffusion when molecules move down a concentration gradient directly through membrane/unaided by carrier molecule;
b. (passive transport by) facilitated diffusion through (specific) channel proteins;
c. osmosis of water via aquaporins/from area of low solute concentration to area of high solute concentration;
d. active transport against a concentration gradient using protein pumps/ATP;
e. vesicles attach to plasma membrane and release materials to exterior/ exocytosis;
f. cell membrane invaginates/pinches off to bring material to interior / endocytosis / phagocytosis;

14b. Hormones such as FSH (follicle stimulating hormone) and LH (luteinizing hormone) affect the development of certain cells by binding to receptors in the plasma membranes. Outline the role of FSH and LH in the menstrual cycle. *[6 marks]*

Markscheme

a. FSH stimulates estrogen secretion by follicle cells;
b. at start of menstrual cycle;
c. leading to development of endometrium;
d. (FSH and) LH (rise to a peak and) causes egg to be released/ovulation;
e. causes follicle cells to secrete less estrogen/more progesterone;
f. progesterone maintains endometrium/uterine lining
g. LH promotes change of follicle to corpus luteum;
h. secretion of LH and FSH regulated by negative feedback;
i. regulated/inhibited by high estrogen and progesterone levels;
j. low progesterone levels cause menstruation;

14c. In the placenta, many substances are transported across membranes. Explain the structure and role of the placenta. *[8 marks]*

Markscheme

a. disc shaped structure
b. embedded in uterus wall;
c. connected to fetus by umbilical cord;
d. contains fetal and maternal structures/tissues;
e. placental villi/maternal intervillous space provide large surface area for exchange of materials;
f. blood of fetus and mother flow close to each other (but no mixing);
g. materials exchanged/diffuse (through membranes) between mother and fetal blood;
h. oxygen/nutrients/antibodies/other substances diffuse (through membranes) to fetus;
i. CO_2 and wastes diffuse (through membranes) to mother;
j. caffeine/drugs/alcohol/viruses from mother may damage fetal development;
k. takes over role of corpus luteum (to produce hormones);
l. produces hormones/estrogen/progesterone/HCG;

15a. Outline the control of the heartbeat by the nervous and endocrine systems. *[6 marks]*

Markscheme

myogenic muscle contraction;
contracts without stimulation;
pacemaker/sino-atrial node/SAN in (wall of) right atrium;
pacemaker/sino-atrial node/SAN initiates contraction;
nerves (from brain) transmit messages to pacemaker;
to alter/increase/decrease the rate of the pacemaker;
medulla of the brain controls heart rate/beat;
epinephrine/adrenaline is hormone produced by adrenal gland;
epinephrine/adrenaline accelerates heart rate/beat;

15b. Explain the principles of synaptic transmission. *[8 marks]*

Markscheme

Ca^{2+}/calcium ions enter presynaptic neuron;
release of neurotransmitter/acetylcholine;
from pre-synaptic membrane/neuron;
diffusion/movement across cleft/gap;
to post-synaptic membrane/neuron;
binding of the neurotransmitter to receptors/binding sites;
change in membrane permeability;
sodium ions flow into post-synaptic neuron;
depolarization of post-synaptic membrane;
initiation of an action potential;
removal of the neurotransmitter;
by enzyme / cholinesterase;
inactivated neurotransmitter returns to pre-synaptic neuron;

16a. Outline, with examples, the types of carbohydrate found in living organisms. *[4 marks]*

Markscheme

(mono-, di- and polysaccharides) consist of one, two and many units;
example of monosaccharide (*e.g.* glucose/ribose/galactose/fructose);
example of disaccharide (*e.g.* maltose/lactose/sucrose);
example of polysaccharide (*e.g.* starch/glycogen/cellulose);

16b. Describe the importance of hydrolysis in digestion. *[6 marks]*

Markscheme

digestion is the breakdown of large molecules into small molecules;
to allow diffusion / to make food soluble;
so foods can be absorbed into the bloodstream/body;
so foods can move from bloodstream into cells;
small molecules can be joined to form the organism's (unique) macromolecules;
hydrolysis is aided by enzymes;
hydrolysis requires water;
polysaccharides (hydrolysed) to disaccharides/monosaccharides/specific example;
proteins/polypeptides (hydrolysed) to amino acids;
fats/lipids/triglycerides (hydrolysed) to fatty acids and glycerol;

16c. Explain the flow of energy between trophic levels in ecosystems. *[8 marks]*

Markscheme

sunlight is the initial source of energy for (most) ecosystems;
sunlight (energy) is converted (through photosynthesis) into chemical/potential energy by producers/plants/autotrophs;
energy escapes from an ecosystem (as heat) / is not recycled;
flow of energy through an ecosystem can be represented as a pyramid of energy; (*allow a suitable diagram*)
energy flow in an ecosystem is measured as energy per unit area/volume, per unit time, for example kJ m^{-2} yr^{-1}/ kJ m^{-3} day^{-1} / other valid unit;
(chemical) energy is passed along the food chain/trophic levels;
primary consumer/herbivores obtain energy from plant food;
secondary/tertiary consumer/carnivores obtain energy by eating other (animals);
energy transfer between trophic levels is not 100 % efficient / is only about 10% efficient;
some energy is lost as heat through respiration;
decomposers obtain energy from waste products/dead bodies/leaf litter;

17a. Outline what is meant by homeostasis. *[4 marks]*

Markscheme

maintaining (stable) internal environment/conditions;
within (narrow) limits;
example (*e.g.* body temperature / blood pH / blood glucose / water / CO_2 concentration);
levels of these variables are monitored (internally);
negative feedback mechanisms / *OWTTE*; (*reject if positive feedback included*)
involves hormonal / nervous control;

17b. Describe how body temperature is maintained in humans. *[6 marks]*

Markscheme

maintained close to 36.7/37°C/98.6°F ;
heat is transferred/distributed in body by blood;
hypothalamus contains thermoreceptors;
hypothalamus monitors temperature/sends message to effectors/causes response;
(vaso) dilation of skin arterioles warms skin/cools body;
(vaso) constriction of skin arterioles retains body heat;
skin/sweat glands produce sweat to cool the body when overheated;
removal of heat through evaporation of sweat;
shivering generates heat / increased metabolism / hair erection to retain heat;
example of behavioural change to warm/cool the body to thermoregulate;

17c. Explain the need for a ventilation system and the mechanism of ventilation of the lungs in humans. *[8 marks]*

Markscheme

(cellular) respiration drives the need for gas exchange/absorption of oxygen and removal of CO_2;
gas exchange depends upon a ventilation system;
lungs/alveoli provide surface area for gas exchange (with capillaries/blood);
ventilation system maintains a high concentration of oxygen in the alveoli;
bloodstream links alveoli to cells;
inhalation by contraction of diaphragm;
inhalation occurs with contraction of external intercostals/relaxation of internal intercostals;
(these) increase the volume/reduce the pressure in thorax, pulling air into lungs;
exhalation caused by relaxation of the diaphragm;
exhalation occurs with relaxation of external intercostals/contraction of internal intercostals;
(these) decrease volume/increase pressure in the thorax, forcing air out of lungs;

18a. Outline, with examples, the types of carbohydrate found in living organisms. *[4 marks]*

Markscheme

(mono-, di- and polysaccharides) consist of one, two and many units;
example of monosaccharide (e.g. glucose/ribose/galactose/fructose);
example of disaccharide (e.g. maltose/lactose/sucrose);
example of polysaccharide (e.g. starch/glycogen/cellulose)

18b. Describe the importance of hydrolysis in digestion. *[6 marks]*

Markscheme

digestion is the breakdown of large molecules into small molecules;
to allow diffusion / to make food soluble;
so foods can be absorbed into the bloodstream/body;
so foods can move from bloodstream into cells;
small molecules can be joined to form the organism's (unique) macromolecules;
hydrolysis is aided by enzymes;
hydrolysis requires water;
polysaccharides (hydrolysed) to disaccharides/monosaccharides/specific example;
proteins/polypeptides (hydrolysed) to amino acids;
fats/lipids/triglycerides (hydrolysed) to fatty acids and glycerol;

18c. Explain the effect of inhibitors on the activity of enzymes. *[8 marks]*

Markscheme

inhibitors reduce enzyme activity/reduce the rate of reaction;

Competitive inhibitors:
have a similar shape to the substrate;
bind to/attach to/enter the active site;
block/compete for occupation of the active site / prevent substrate binding;
example (*e.g.* succinate dehydrogenase by malonate);
increase in substrate concentration reduces inhibition / graph showing this;

Non-competitive inhibitors:
not chemically similar / different shape to substrate;
attach to a different part of the enzyme/allosteric site;
shape of the active site changes preventing/reducing substrate binding;
example of non-competitive inhibition (*e.g.* respiratory enzymes by cyanide);
increases in substrate concentration do not reduce inhibition / graph showing this;
end-product inhibitors are non-competitive;

19a. List the general functions of non-membrane proteins. *[4 marks]*

Markscheme

contraction / movement;
acts as a catalyst/enzymes / specific example of an enzyme function;
structure / support / specific example of a structural/support role;
transport;
defence / immunity;
as hormones / communication;
DNA packing / histones;
other function;

19b. Outline the digestion, absorption and assimilation of proteins in humans. *[6 marks]*

Markscheme

large molecules (proteins) must be digested into small molecules;
a protease/pepsin digests proteins into polypeptides;
pepsin works in the stomach / requires an acid/low pH/pH 2 to work;
polypeptides are digested by a protease/trypsin into amino acids;
trypsin acts in the small intestine / requires a basic pH/pH 8/high pH;
amino acids absorbed by diffusion/active transport;
absorption occurs in the villus/microvilli of the small intestine;
(amino acids absorbed) into capillaries;
blood carries amino acids throughout the body;
amino acids diffuse into cells/are absorbed by active transport;
cells use amino acids to build proteins;
assimilation is when amino acids become part of a cell;
proteins are synthesized at the ribosomes/ER of the cell;

19c. Actin and myosin are two proteins found in muscles. Explain how skeletal muscle contracts, including the interaction of these proteins. *[8 marks]*

Markscheme

motor neuron stimulates the muscle fibre;
calcium ions are released (from sarcoplasmic reticulum);
calcium ions bind to troponin;
tropomyosin moved / binding sites of actin revealed;
ATP binds (to myosin) causing cross-bridges to break;
ATP becomes ADP causing myosin heads to change angle/become cocked;
(myosin) heads attach to (new) actin sites/form cross-bridge;
ADP released;
myosin heads move actin filaments toward centre;
making sarcomere shorter;
calcium ions are reabsorbed (into the sarcoplasmic reticulum);
muscle fibre relaxes;
Award the above points if shown in a clearly drawn, correctly annotated diagram.

20a. Distinguish between ventilation, gas exchange and cell respiration. *[4 marks]*

Markscheme

ventilation is moving air into and out of lungs/inhalation and exhalation;
involves (respiratory) muscle activity;
gas exchange involves movement of carbon dioxide and oxygen;
between alveoli and blood (in capillaries) / between blood (in capillaries) and cells;
cell respiration is the release of energy from organic molecules/glucose;
(aerobic) cell respiration occurs in mitochondria;
*To award **[4 max]** responses must address ventilation, gas exchange and cell respiration.*

20b. Outline the process of aerobic respiration. *[6 marks]*

Markscheme

during glycolysis glucose is partially oxidized in the cytoplasm;
(small amount/yield of) ATP produced;
(two) pyruvate formed by glycolysis;
pyruvate absorbed into/broken down in the mitochondrion;
requires oxygen;
carbon dioxide is produced;
water is produced;
large amount/yield of energy/ATP molecules (per glucose molecule);

20c. Respiration and other processes in cells involve enzymes. Explain the factors that can affect enzymes. *[8 marks]*

Markscheme

collisions between enzyme/active site and substrate;
enzyme activity increases as temperature rises;
more frequent collisions at higher temperatures;
each enzyme has an optimum temperature / enzymes have optimal temperatures;
high temperatures (above optimum) denature enzymes;
each enzyme has an optimum pH / enzymes have optimal pHs;
increase or decrease from optimum pH decreases rate of reaction/activity;
extreme pH alters/denatures the tertiary/3D protein/enzyme structure;
increasing substrate concentration increases the rate of reaction;
higher substrate concentration increases chance of collision;
until plateau;
when all active sites are busy;
Accept clearly annotated graph.

21a. Describe the production of semen. *[6 marks]*

Markscheme

sperm produced by meiosis;
in testis/seminiferous tubules;
sperm are stored/mature in the epididymis;
sperm able to swim;
seminal vesicles add fluid;
(seminal) fluid rich in fructose;
prostate gland adds fluids;
fluid rich in proteolytic enzymes/citric acid/acid phosphatase/lipids/minerals;
(semen) contains basic amines/alkaline substances;
which neutralizes acid/hostile environment of the vagina;

21b. Explain the structure and function of the placenta. *[8 marks]*

Markscheme

disc-shaped structure;
connected to the fetus by an umbilical cord;
placenta is embryonic and maternal tissue;
placental villi increase the surface area (for exchange);
fetal capillaries in placenta/placental villi;
inter-villous spaces/sinuses through which mother's blood flows;
fetal and mother's blood do not mix / small distance between fetal and mother's blood;
transfer of foods/nutrients/glucose from mother to fetus;
fetal gas exchange/transfer of oxygen from mother to fetus;
transfer of excretory/waste products/CO_2 from fetus to mother;
transfer of antibodies/hormones from mother to fetus;
secretion of estrogen/progesterone/HCG;
Allow reference to embryo instead of fetus throughout.

21c. Outline the hormonal control of birth. *[4 marks]*

Markscheme

at about 38 to 40 weeks pregnancy/end of pregnancy/progesterone levels decrease;
removes inhibition of oxytocin secretion;
(oxytocin) released from (posterior) pituitary;
oxytocin stimulates uterus contraction;
cervix widens/dilates;
increase in oxytocin increases rate and intensity of contractions;
positive feedback;

22a. Outline the role of the skin in temperature regulation. *[5 marks]*

Markscheme

heat causes vasodilation of arterioles;
blood closer to surface so heat loss from skin;
heat causes sweating (from sweat glands);
evaporation of sweat leads to cooling;
cold causes vasoconstriction of arterioles;
less blood at surface so less heat loss from skin;
cold leads to less sweating/evaporation of water from skin / hair becomes erect and traps air/goose bumps appear;
temperature receptors in skin transmit impulses to the hypothalamus;

22b. Outline the role of hormones in the process of birth in humans *[4 marks]*

Markscheme

level of progesterone falls before birth;
oxytocin secreted;
from pituitary;
this stimulates contractions of uterus;
uterine contraction/stretching of cervix/vagina stimulates secretion of (more) oxytocin;
form of positive feedback;

22c. Explain the principles of vaccination. *[9 marks]*

Markscheme

vaccine is a modified/weakened/attenuated form of a pathogen / contains antigens from pathogens;
vaccine injected/ingested/introduced to patient;
pathogen/antigens stimulates specific immune response called primary/initial responses;
antigens stimulate macrophages/lymphocytes/T-cells;
which stimulate cloning of B-cells/plasma cells;
including development of memory (B-)cells;
that produce specific antibodies;
(upon second exposure) production of antibodies is much faster;
higher level of antibody production / person has immunity;
called secondary response;
labelled graph showing curve with higher slope/peak for secondary response than primary response;
may need booster shot to maintain immunity;
this is an example of active/artificial immunity;

23a. The pumping of blood is a vital process. Explain the roles of the atria and ventricles in the pumping of blood. *[4 marks]*

Markscheme

atria collect blood from veins (vena cava/pulmonary);
collect blood while ventricles are contracting;
atria pump blood into ventricles/ensure ventricles are full;
ventricles pump blood into arteries/out of the heart;
ventricles pump blood at high pressure because of their thicker, muscular walls;
mention of heart valves working with atria and ventricles to keep blood moving;
left ventricle pumps blood to systems and right ventricle pumps blood to lungs;

Both left and right ventricles with correct function required for mark to be awarded.

23b. Explain how the structure of an artery allows it to carry out its function efficiently. *[5 marks]*

Markscheme

thick wall to withstand high blood pressures/avoid bursting/leaks;
many muscle fibres to help pump blood;
many elastic fibres to stretch and pump blood after each heart beat;
narrow lumen to maintain high pressure/because blood flows along rapidly;
thick outer layer of collagen to give strength/prevent aneurism;
no valves as pressure is high enough to prevent backflow;
endothelium/smooth inner lining to reduce friction;

24a. Compare simple diffusion with facilitated diffusion as mechanisms to transport solutes across membranes. *[5 marks]*

Markscheme

*Award **[1]** for each linked set of answers.*

	simple diffusion	facilitated diffusion
energy requirement	none	none;
direction of movement	down concentration gradient	down concentration gradient;
specificity	not specific	specific;
passage directly through phospholipid membrane	yes	no;
protein channels	not required	required;
solute	simple molecules / O_2 / CO_2	sugars/amino acids;
solute binding to carriers	no	yes;
speed of diffusion	slower	faster;

24b. Describe the process of endocytosis. *[5 marks]*

Markscheme

endocytosis occurs when a membrane encloses a target particle;
fluidity of membrane permits movement of membrane;
membrane sinks inwardly/forms pit/invaginates to enclose particle;
membrane seals back on itself / edges fuse;
one membrane layer / two phospholipid layers enclose particle making vesicle;
inner phospholipid layer of (original) membrane becomes outer phospholipid layer of vesicle membrane;
outer phospholipid layer of (original) membrane becomes inner phospholipid layer of vesicle membrane;
vesicle breaks away from membrane/moves into cytoplasm;
changes in membrane shape require energy;
specific example of endocytosis (*e.g.* pinocytosis, phagocytosis);
Accept any of the above points in an annotated diagram.

24c. Explain how an impulse passes along the membrane of a neuron. *[8 marks]*

Markscheme

resting membrane is polarized;
interior is –70 mV/negative relative to outside;
more sodium ions outside than inside;
more potassium ions inside than outside;
disturbance of membrane opens sodium ion channels;
sodium ions rush to inside of cell;
causing depolarization;
sodium ion channels shut;
potassium ion channels open;
potassium ions rush out;
helping to restore polarized state of membrane;
sodium-potassium pumps maintain polarity;
process repeated along the length of neuron / sodium ions diffuse between region with an action potential and the region at resting potential;

25a. Outline the process of glycolysis. *[5 marks]*

Markscheme

occurs in cytoplasm;
hexose is phosphorylated using ATP;
hexose phosphate is split into two triose phosphates;
<u>oxidation</u> by removal of <u>hydrogen</u>; (*do not accept hydrogen ions/protons*)
conversion of NAD to NADH ($+H^+$);
net gain of two ATP / two ATP used and four ATP produced;
pyruvate produced at the end of glycolysis;
Accept glucose/fructose/6C sugar instead of hexose.
Accept 3C sugar/glyceraldehyde instead of triose.

25b. Describe how pancreatic cells directly affect blood glucose levels. *[5 marks]*

Markscheme

α cells (of pancreas) produce glucagon;
glucagon promotes release of glucose/breakdown of glycogen by liver cells;
glucagon secreted when blood glucose levels are low / raises blood glucose levels;
β cells (of pancreas) produce insulin;
insulin promotes glucose uptake/storage of glycogen by liver/body/muscle cells;
insulin secreted when blood glucose levels are high / lowers blood glucose levels;
negative feedback mechanism;
Do not accept answers implying that insulin or glucagon catalyse glucose-glycogen conversions directly.
*Award **[3 max]** if the response suggests that the hypothalamus has a role in regulation of blood glucose.*

25c. Explain why diabetes could be detected through the analysis of urine. *[8 marks]*

Markscheme

urine of diabetics contains glucose;
whereas urine of non-diabetics contains no glucose;
glomerular filtrate contains glucose / glucose filtered out;
glucose (normally) reabsorbed from filtrate/into blood;
through wall of / in the proximal convoluted tubules;
blood glucose concentration higher than normal in diabetics;
reabsorption not completed / pumps cannot reabsorb all glucose in diabetics;
glucose in urine can be detected using test strips;
type I diabetes is lack of insulin secretion / lack of β cells;
type II diabetes is body cells not responding to insulin / not absorbing glucose;

26a. Describe the relationship between the structure and function of blood vessels. *[6 marks]*

Markscheme

arteries carry blood under high pressure;
they have a thicker elastic wall/narrower lumen;
they have muscles that control pressure / help move the blood;

veins carry blood under lower pressure;
they have thin walls with less elastic tissue/muscle/wider lumen;
have valves to prevent back flow;

capillaries have walls which are <u>one cell thick</u>;
to allow easy diffusion across their wall / ultrafiltration;
(some) capillaries have pores/clefts;
*Award **[5 max]** if capillaries are not referred to.*

26b. Explain the mechanisms involved in the ventilation of the lungs. *[8 marks]*

Markscheme

external intercostal muscles contract;
internal intercostal muscles relax;
pulling the rib cage upwards;
diaphragm contracts and flattens;
increase in volume of thoracic cavity;
this reduces pressure;
so air enters the lungs;
internal intercostal muscles contract / external intercostal muscles relax;
diaphragm relaxes;
abdominal muscles/organs/liver push diaphragm upwards;
decrease in volume of thoracic cavity;
increases the pressure;
so air leaves the lungs;
Award any of the above points if clearly drawn in a diagram.

27a. Outline a possible cause of Down syndrome. *[4 marks]*

Markscheme

non-disjunction (can cause Down syndrome);
occurs when pair of homologous chromosomes fails to separate during meiosis;
one gamete/daughter cell receives two chromosomes / diagram showing this;
occurs in anaphase I/II of meiosis;
fertilization involving this gamete leads to change in chromosome number/47 chromosomes;
most common form of Down is trisomy 21/extra chromosome 21;
increase risk of Down syndrome with increased age of mother;

27b. Outline the processes involved in oogenesis within the human ovary. *[8 marks]*

Markscheme

oogenesis is process by which female gametes/eggs are produced;
begins during fetal development; oogonia/large number of cells formed by mitosis;
oogonia/cells enlarge/undergo cell growth/become primary oocytes;
begin first meiotic division but stop in Prophase I;
until puberty;
(at puberty) some follicles develop each month in response to FSH;
(primary oocyte) completes first meiotic division;
forms two cells of different/unequal sizes / unequal distribution of cytoplasm;
(creating a) polar body;
polar body eventually degenerates;
larger cell/secondary oocyte proceeds to meiosis II;
stops at prophase II;
meiosis II completed if cell is fertilized;
ovum and second polar body formed;

27c. Discuss the ethical issues surrounding IVF. *[6 marks]*

Markscheme

To award full marks, discussion must contain both pro and con considerations.

pros/positive considerations: ***[3 max]***
chance for infertile couples to have children;
decision to have children is clearly a conscious one due to difficulty of becoming pregnant;
genetic screening of embryos could decrease suffering from genetic diseases;
spare embryos can safely be stored for future pregnancies/used for stem cell research;

cons/negative considerations: ***[3 max]***
IVF is expensive and might not be equally accessible;
success rate is low therefore it is stressful for the couple;
it is not natural/cultural/religious objections;
could lead to eugenics/gender choice;
could lead to (unwanted) multiple pregnancies with associated risks;
production and storage of unused embryos / associated legal issues / extra embryos may be used for (stem cell) research;
inherited forms of infertility might be passed on to children;
Accept any other reasonable answers.

28a. Draw a labelled diagram of the adult female reproductive system. *[4 marks]*

Markscheme

Award ***[1]*** *for each structure clearly drawn and correctly labelled.*
ovary – shown adjacent to but not joined to oviduct/fallopian tube;
oviduct/fallopian tube – shown as a tube leading into a uterus;
uterus – shown with a thicker wall than oviduct/fallopian tube;
vagina – shown leading from the uterus, connected to the cervix;
cervix – shown as a constriction between the vagina and uterus;
endometrium – shown as inner lining of uterus;

28b. Outline the roles of progesterone and estrogen in the human menstrual cycle *[6 marks]*

Markscheme

follicles secrete estrogen / FSH stimulates secretion of estrogen;
(rapid) increase in estrogen stimulates FSH/LH production;
estrogen also stimulates repair/thickening of endometrium/uterus lining;
LH causes follicle to produce less estrogen/more progesterone;
corpus luteum secretes more estrogen/progesterone;
progesterone maintains/stimulates thickening of endometrium/uterus lining;
estrogen/progesterone inhibit FSH/LH secretion;
estrogen/progesterone levels fall after day 21–24 if no embryo/fertilization;
lower concentration of estrogen/progesterone allows disintegration of endometrium/uterus lining / menstruation occurs;
Award ***[4 max]*** *if only one hormone is explained.*

28c. Explain the function and structure of the placenta. *[8 marks]*

Markscheme

transfer of foods/nutrients/glucose from mother to fetus;
fetal gas exchange/transfer of oxygen from mother to fetus;
transfer of excretory products/CO_2 from fetus to mother;
transfer of antibodies/hormones from mother to fetus;
secretion of estrogen/progesterone;
from approximately 12 weeks / when ovary/corpus luteum stops secretion;
disc shaped structure;
connected to the fetus by an umbilical cord;
embryonic tissue invades/grows into the uterine wall;
placental villi increase the surface area (for exchange);
fetal capillaries in placenta/placental villi;
inter-villous spaces/sinuses through which mother's blood flows;
small distance between fetal and mother's blood/narrow placental barrier;
Allow reference to embryo instead of fetus throughout.

29a. Draw a labelled diagram of the heart showing the chambers, associated blood vessels and valves. *[4 marks]*

Markscheme

*Award **[1]** for each structure clearly drawn and correctly labelled. Schematic diagrams are acceptable.*
right and left ventricles – not connected shown larger than atria;
right and left atrium – not connected, thinner walls than ventricles;
right ventricle has thinner walls than left ventricle / *vice versa*;
atrio-ventricular valves / tricuspid and bicuspid valves – shown between atria and ventricles;
aorta and pulmonary artery – shown leaving the appropriate ventricle with semilunar valves shown;
pulmonary vein and vena cava – shown entering appropriate atrium;
Vessels must join unambiguously to correct chamber.

29b. Describe the processes involved in blood clotting. *[6 marks]*

Markscheme

cells/tissue is damaged/cut/bruised;
damaged cells/platelets release clotting factors;
(clotting factors cause the) production of thrombin;
blood plasma contains soluble fibrinogen;
fibrinogen converted into fibrin;
by thrombin;
forms a net of fibres trapping blood cells;
forming a clot / prevents blood loss / entry of bacteria/pathogens;
cascade of reactions/series of stages prevent accidental clotting/speed up clotting;

29c. Discuss the benefits and risks associated with vaccination programmes. *[8 marks]*

Markscheme

benefits: ***[6 max]***
immunity results
can limit pandemics/epidemics/spread of (infectious) diseases;
diseases can be eradicated/smallpox eliminated;
reduces mortality/deaths due to disease;
can protect vulnerable groups/young/old/with other conditions;
decreases crippling effects of diseases (such as polio);
decreased health care costs;

risks: ***[6 max]***
may produce (mild) symptoms of the disease;
human error in preparation/storage/administration of vaccine;
individual may react badly to vaccine / defective immune system / hypersensitive/allergic reaction;
immunity may not be life-long / booster required;
possible toxic effects of mercury-based preservatives/thimerosal;