Chapter 6 Short Answer *[205 marks]*

1a. Draw a labelled diagram showing the **interconnections** between the liver, gall bladder, pancreas and small intestine. *[2 marks]*

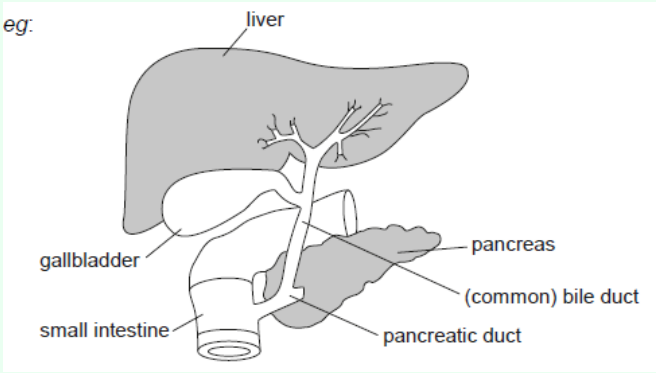
Markscheme

a. pancreas linked to small intestine by (pancreatic) duct (pancreas and small intestine both must be labelled);

b. gall bladder shown associated with liver and linked to small intestine by (bile) duct, (gall bladder and small intestine must be labelled);

c. showing (bile and pancreatic) ducts joined together before discharging in small intestine;

Ducts are to be drawn as double line structures.



1b. Outline the role of glucagon in homeostasis of glucose. *[2 marks]*

Markscheme

a. (glucagon) released in response to low blood glucose levels;

b. (glucagon) increases blood glucose levels;

c. glucagon leads to conversion of polysaccharides/glycogen (in the liver) to glucose;

Do not accept implication that glucagon directly converts glycogen to glucose.

1c. List **two** examples of polysaccharides. *[1 mark]*

Markscheme

starch / glycogen / cellulose

*Award **[1]** for any two polysaccharides.*

2a. Compare blood glucose levels after fasting in young control mice and young IKO mice without FoxO1. *[2 marks]*

Markscheme

a. similar/same/nearly same (means)/very small difference/both at a low level;
b. means/averages (all) close to 0.8 mg ml^{-1};
c. difference not (statistically) significant;
d. similar/same/nearly same range of values/spread of data;

All marking points are comparisons between control and IKO mice. Do not award marks for comparisons between male and female mice.

2b. Estimate the difference between mean blood glucose levels in control and IKO older female mice. *[1 mark]*

.....mg ml^{-1}

Markscheme

1 mg ml^{-1} (accept values between 0.8 – 1)

2c. Aging and having pregnancies are considered to be physiological stresses. Deduce the effect of stress on blood glucose levels. *[2 marks]*

Markscheme

a. stress causes increase in (mean) blood glucose/sugar;
b. older mice/males/females / aging mice show the increase;
*Reject answers that **only** compare control and IKO mice or **only** compare male and female mice.*

2d. Outline the relationship between blood glucose levels after fasting and lack of FoxO1 in the mice studied. *[2 marks]*

Markscheme

a. in young mice/3 month old mice lack of FoxO1/IKO/fewer beta cells does not affect/has little effect on blood glucose/sugar;
b. in older females/aging males blood glucose/sugar (much) higher with lack of FoxO1/IKO/fewer beta cells;

2e. State the correlation between lack of FoxO1 and pancreatic hormones in mice. *[1 mark]*

Markscheme

lack of FoxO1 (correlates) with low/decreased insulin and high/increased glucagon levels.

2f. Referring to the functions of insulin and glucagon, suggest how the differences in hormone levels help to explain the blood glucose levels. *[3 marks]*

Markscheme

a. insulin used to take up/reduce glucose levels (after eating/when blood glucose levels high);
b. decrease in insulin in FoxO1 lacking/IKO mice would cause increase in glucose levels (as less is removed);
c. glucagon (used to convert stored carbohydrate to glucose) to increase glucose levels;
d. increase in glucagon (as seen in second graph, where IKO level higher than control) would mean more glucose added to blood/increase in glucose levels (on first graph);
e. (on first graph) see older/stressed/adult female mice with much higher glucose levels than young mice;

3a. Define *pathogen*. *[1 mark]*

Markscheme

Organism (or virus) that causes a disease.

3b. Explain antibody production. *[3 marks]*

Markscheme

a. many types of lymphocytes (B and T) exist;
b. produced/ stored in the lymph nodes;
c. each type recognizes one specific antigen/pathogen;
d. each type responds by dividing to form a clone;
e. (a clone) (B) lymphocyte secretes (specific) antibody against the antigen;
f. antibodies are produced as part of a specific immune response;
g. some reference to plasma/memory cells;

3c. Explain why antibiotics are effective against bacterial diseases but not against viral diseases. *[2 marks]*

Markscheme

a. antibiotics block metabolic pathways of bacteria / reference to a specific pathway;
b. viruses have no metabolic pathways / viruses reproduce using the host cell's metabolic pathways;
c. (host cell's) metabolic pathways are not affected by antibiotics / (antibiotics) do not affect host cells because they are metabolically different from bacteria;

4a. Outline the symptoms of type II diabetes. *[2 marks]*

Markscheme

a. high blood sugar/glucose levels;

b. sugar/glucose in urine;

c. increased thirst/frequent urination;

d. hunger/weight loss/fatigue/blurred vision/slow healing/skin disorders;

4b. Explain the dietary advice that should be given to a patient who has developed type II diabetes. *[3 marks]*

Markscheme

a. reduce blood glucose levels as target/ body/muscle cells less sensitive toinsulin / not enough insulin produced;
b. reduce intake of (saturated) fats, to reduce weight;
c. reduce the intake of sugar/simple carbohydrates, causes rapid increase in blood glucose concentration;
d. eat more high fibre foods, satisfy appetite, but cannot be broken down;
e. regular/many small meals, to avoid (rapid) rise in glucose after a big meal;
f. eat complex carbohydrates/carbohydrates with a low glycemic index, digested and absorbed more slowly;
To award the mark, answers require dietary recommendations with a reason. Do not accept comments about increased exercise.

5a. Distinguish between type I and type II diabetes. *[2 marks]*

Markscheme

type 1 caused by destruction of insulin secreting cells/beta cells (in pancreas) / insufficient insulin produced / genetic disorder resulting in failure to produce insulin;

type II caused by decreased response of body cells/receptors to insulin (that is produced);

type I early onset while type II adult onset;

type I treated with insulin while type II with diet (lifestyle changes);

5b. State the relationship between plasma fatty acid level and enzyme activity. *[1 mark]*

Markscheme

negative/inverse relationship/negative correlation / as one variable increases the other decreases / as plasma fatty acid increases, enzyme activity decreases / *vice versa*

5c. Calculate the percentage change of enzyme activity after 5 hours exposure to lipids. *[1 mark]*

Markscheme

(a decrease of) 45 (%) *(accept answers in the range of 44 (%) to 47 (%))*

5d. Discuss, using the data, whether the effect of lipids on this enzyme is reversible. *[2 marks]*

Markscheme

yes, effect is reversible as activity returns to (approximately) original level (when lipids/fatty acids decrease);

when lipid/fatty acids washed out enzyme is more active/activity increases;

difference between starting and final levels of enzyme activity is insignificant because of error bars;

three hours/experimental time may be insufficient to reverse the effect

5e. Calculate the increase in glucose absorption when insulin is increased from 0 to 10^3 μU ml^{-1} for the muscle bathed in lipid. *[1 mark]*

_____% of absorption with no insulin

Markscheme

300

5f. Comment on the effect of increased insulin concentration on glucose absorption in the muscle bathed in lipid. *[2 marks]*

Markscheme

increased insulin concentration causes more glucose absorption (up to 10^3 µU ml^{-1});

glucose absorption in muscle bathed in lipid always less than control;

no further increase/slight decrease in glucose absorption beyond 103 (µU ml^{-1}) insulin;

5g. Some investigators suggest that there is a strong relationship between high lipid diet and the body's response to insulin. Using the data provided, evaluate this hypothesis. *[2 marks]*

Markscheme

Referring to first graph:
plasma lipids lower activity of enzyme (needed for glucose absorption);

Referring to second graph:
more/higher glucose uptake with higher insulin levels in muscles without lipids (compared to muscles bathed in lipids);
lipids reduce glucose absorption (even at raised insulin concentrations);
isolated muscle used in experiments so results may differ in whole organisms;

6. Outline a mechanism used to transport products of digestion from the lumen of the ileum into the blood. *[3 marks]*

Markscheme

facilitated diffusion;

substance moves from high to low concentration/ down concentration gradient;

protein channels needed;

does not require ATP/energy / passive;

valid example; *(eg amino acids / glucose / fructose / water soluble vitamins)*

or

active transport;

substance moves from low to high concentration / against concentration gradient;

membrane pumps needed / Na/K pump, Ca^{++};

ATP/energy required;

valid example; *(eg amino acids / glucose / mineral irons / iron)*

or

endocytosis/pinocytosis;

droplets of intestinal fluid surrounded by membrane;

forms vesicle;

vesicles are released inside villus cell;

valid example; *(eg fat soluble vitamins)*

Accept appropriate diagram.

7a. Outline the control mechanism for appetite in humans. *[2 marks]*

Markscheme

a. appetite control centre (in brain) makes person feel full/satiated/hungry;
b. function is both nervous and hormonal;
c. after eating (centre) responds to hormones/insulin from pancreas/hormones/PYY from small intestine/hormones from adipose tissue/leptin in response to fat storage;
d. centre responds to hormone/ghrelin released from empty stomach;
e. part of centre responds to levels of lipid/sugar in the blood;

7b. Explain the possible health consequences of a diet rich in protein. *[3 marks]*

Markscheme

a. high amount of one nutrient may cause deficiency in another one;
b. excess protein not stored as protein by the body / converted to fat;
c. results in weight/mass loss in many people (due to fat/carbohydrate deficiency);
d. health problems such as kidney stones/other health problems;
e. high protein as part of a weight/mass loss diet;

8a. Calculate the difference in blood pressure at systole between rest and exercise before flight, giving the units. *[1 mark]*

Markscheme

142–117/25 mm Hg (*Units required*)

8b. Outline the response of the astronauts' cardiovascular system to exercise before the flight. *[2 marks]*

Markscheme

a. pressure at systole/diastole / diastolic/systolic pressure increases;
b. pressure at diastole/diastolic pressure does not change much;
c. time between heartbeats decreases / heart beats/rate faster;

8c. Discuss whether the cardiovascular system has to adjust to weightless conditions in space. *[3 marks]*

Markscheme

Arguments supporting the need for adjustment:
a. (blood) pressure increased but then decreased later in flight;
b. time between heartbeats (at rest) increased then decreased / heart rate decreased then increased;

Arguments not supporting the need for adjustment:
c. (blood) pressure/time between heartbeats/heart rate does not change (much) in space;
d. data is from a few trained astronauts and may not reflect general population / *OWTTE*;
e. data for more extended periods of time not included (so difficult to evaluate);
*Award **[2 max]** if only one perspective is presented.*

9a. State the role of ligaments in human movement. *[1 mark]*

Markscheme

connect bones to bones / enable joint movement/flexibility/articulation/ prevent dislocation

9b. Explain the changes in ventilation rate during exercise. *[2 marks]*

Markscheme

a. increased (muscle) cell respiration releases more CO_2/decreases pH (in blood);
b. detected by (respiration centre in) brain/medulla;
c. signal sent to respiratory muscles to contract at a faster rate;
d. more oxygen carried by the blood / needed for aerobic (cell) respiration;

10. List **two** reasons for increases in the rate of clinical obesity. *[2 marks]*

1. .....
2. .....

Markscheme

a. high calorie / fatty food;
b. cheap high-energy food;
c. large portions / overeating;
d. lifestyles with less physical activity;
e. economic growth / increases in wealth;

11a. State the relationship between asthma and lung function. *[1 mark]*

Markscheme

(children) with asthma have lower lung function / (children) without asthma have higher lung function

11b. Calculate the change in lung function of females with asthma between the ages of 11 and 26. *[1 mark]*

Markscheme

7 % (*units needed*) (*accept answers in the range of 6 % to 8 %*)

11c. Compare the data for 26-year-old males and females. *[2 marks]*

Markscheme

a. female lung function higher than male;
b. males and females both better (lung function) without asthma;
c. males with asthma have a greater reduction in lung function / greater difference between males and females with asthma than without asthma;

11d. Explain how the units used to measure lung function are useful in showing if a person suffers from asthma. *[2 marks]*

Markscheme

a. asthma causes constriction/congestion/inflammation of the airways/breathing tubes/bronchi/bronchioles;
b. units measure ability to exhale quickly/efficiently which could indicate asthma;

12a. State the surfactant that contains the least amount of phospholipids. *[1 mark]*

Markscheme

natural human (surfactant)

12b. Compare the composition of natural human surfactant with synthetic surfactants. *[2 marks]*

Markscheme

main component of all surfactants is phospholipids;
(natural human surfactant) has less phospholipids (than synthetic surfactants);
(natural human surfactant) has more cholesterol (than (synthetic surfactant) A);
(natural human surfactant) has more free fatty acids than (synthetic surfactant) A and less than (synthetic surfactant) B; (*comparison with both synthetic surfactants required*)
(natural human surfactant) has more proteins (than synthetic surfactants);

12c. Phospholipids found in the surfactants form a surface film on the moist lining of the alveoli. Outline how the hydrophilic and hydrophobic parts of the phospholipids in the surfactants are aligned on the alveolar surface. *[1 mark]*

Markscheme

hydrophilic groups facing the surface/are in the moist lining/water and hydrophobic tails facing outwards/are in the air
*Award **[0]** for a description of a phospholipid bilayer. The orientation of both hydrophilic and hydrophobic parts must be included.*

12d. Identify the effect of increasing the concentration of synthetic surfactant A on the growth of GBS. *[1 mark]*

Markscheme

growth reduced (by increases in concentration)/negative correlation

12e. Compare the effect of the three surfactants, synthetic surfactants A and B and the modified human surfactant, on the growth of the different bacteria at a concentration of 20 mg ml^{-1}. *[3 marks]*

Markscheme

The question asks to compare how each surfactant affects each bacterium. However, some responses will instead compare how each bacterium is affected by each surfactant. Accept both types of answer.

(synthetic surfactant) A decreases growth of GBS most and *S. aureus* and *E. coli* much less/slightly;
(synthetic surfactant) B decreases the growth of GBS (and of *S. aureus* slightly) but increases the growth of *E. coli*;
modified human surfactant decreases growth of GBS (and *S. aureus*) but no (significant) effect on *E. coli*;
GBS greatly inhibited by (synthetic surfactant) A but less/slightly by (synthetic surfactant) B and modified human surfactant;
S. aureus (slightly) inhibited by all three surfactants;
E. coli increased by (synthetic surfactant) B but (synthetic surfactant) A and modified human surfactant have no significant effect;

12f. Using all the data provided, evaluate the hypothesis that the presence of proteins in surfactants can decrease bacterial growth. *[3 marks]*

Markscheme

(*hypothesis supported as*)
(synthetic surfactant) A has proteins and decreases bacterial growth;

(*hypothesis not supported as*)
modified human surfactant has no proteins and decreases bacterial growth;
(synthetic surfactant) B has proteins and enhances growth (of *E. coli*);
GBS inhibited more by modified human surfactant which has no protein than (synthetic surfactant) B which has protein;
S. aureus inhibited more by modified human surfactant which has no protein than by the other (surfactants) which have protein;
Do not accept answer without reference to proteins.

13. Blood transports molecules throughout the body. State where the blood absorbs oxygen. *[1 mark]*

Markscheme

alveoli / lungs

14a. Outline the mechanisms involved in the control of heartbeat. *[3 marks]*

Markscheme

myogenic contraction / muscles contract without stimulus from a nerve;
pacemaker/SA node initiates each heart beat/stimulates atria to contract;
nerves carry impulses from the brain to speed up and slow down the heart;
medulla (of the brain) monitors blood pressure;
epinephrine/adrenaline increases rate/strength of contractions;

14b. Explain how the direction of blood flow in the heart is controlled. *[2 marks]*

Markscheme

valves open/close due to blood pressure differences;
valves prevent backflow/only allow unidirectional flow;
atrioventricular valves between ventricles and atria;
semilunar valves between arteries and ventricles;
Accept mitral/bicuspid and tricuspid in place of atrioventricular.
Accept aortic and pulmonary in place of semilunar valves.

15a. Outline the process of *in vitro* fertilization (IVF). *[3 marks]*

Markscheme

mother receives hormone treatment/FSH to stimulate egg development;
eggs and sperm collected/harvested / eggs taken from ovary;
egg fertilized outside the body/in a dish/in a lab;
develops into embryo;
embryo(s) implanted (artificially) in mother's body/uterus;
Do not accept egg/fertilized egg/zygote implanted.

15b. Identify the cell labelled X. *[1 mark]*

Markscheme

Sertoli cell / nurse cell

15c. Outline the function of this cell. *[1 mark]*

Markscheme

nourishes maturing sperm(atozoa) / protects sperm from lymphocytes

15d. Explain how meiosis results in genetic variation in gametes. *[2 marks]*

Markscheme

crossing over in prophase 1/between chromatids;
random orientation of bivalents/homologous pairs in metaphase 1;
random orientation of chromatids/chromosomes in metaphase 2;

16a. Label the diagram to show the structure that is involved in digestion of proteins in acid conditions (using the letter A). *[1 mark]*

Markscheme

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

stomach (*labelled A*)

16b. Label the diagram to show the structure where **most** absorption of water to prevent dehydration occurs (using the letter B). *[1 mark]*

Markscheme

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

large intestine (*labelled B*)

16c. Label the diagram to show the structure where **most** absorption of nutrients occurs (using the letter C). *[1 mark]*

Markscheme

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

small intestine / ileum (*labelled C*)

16d. Explain how the structure of veins is adapted to their function. *[2 marks]*

Markscheme

valves to avoid backflow;
thin wall allows them to be pressed flat by muscles to move/carry blood under low pressure;
wide lumen (for a given blood vessel diameter) for slow flowing blood;

16e. Cells defend the body against pathogens. Outline how some of these cells ingest pathogens in the blood and in body tissues. *[2 marks]*

Markscheme

attraction to foreign protein/pathogen / chemotaxis;
membrane invaginates / engulfs foreign matter / phagocytosis/endocytosis;
formation of vacuole/vesicle;
(phagocytes) can squeeze out of walls of capillaries;
Accept clearly annotated diagrams.

17a. Outline the effect of CXCL12 inhibition on the incidence of diabetes. *[2 marks]*

Markscheme

CXCL12 inhibition initially decreases occurrence of diabetes;
in the first 25 / up to 26/27/28 weeks;
CXCL12 inhibition does not prevent occurrence of diabetes (just delays it) / eventually the same level of diabetes

17b. Suggest how the breakdown of CXCL12 in the bone marrow may be related to diabetes. *[1 mark]*

Markscheme

CXCL12 breakdown allows stem cell mobilization reducing incidence of diabetes / stem cells from the bone marrow can regenerate the islets (in pancreas)

17c. Evaluate the possible use of isoprenaline in the treatment of diabetes. *[2 marks]*

Markscheme

isoprenaline is an inhibitor of CXCL12 / inhibits synthesis of CXCL12 mRNA;
delays onset of diabetes / allows stem cell mobilization / allows islet regeneration;
does not cure the disease;

17d. Research is being conducted into treatment for diabetes based on stem cells. Discuss the ethical issues involved in stem cell research. *[3 marks]*

Markscheme

suffering of patients could be reduced / diseases could be cured / better treatments developed / might replace treatment with cure;
(possibly) less cost than treating disease/diabetes;
specific example of ethical conflict; (*e.g. patient groups support use of embryotic stem cells but religious groups oppose / different views on the moral status of an embryo*)
restrictions on research in some countries due to cultural/religious traditions;
still in experimental stages / risk to patient;
specific example of risk; (*e.g. stem cells developing into tumours / rejection / need for immunosuppressants*)
death of early-stage embryos / production of embryos for stem cell research;
use of stem cells from adults/patients could overcome these objections;

17e. State the maximum number of stem cells per ml blood in the control mice. *[1 mark]*

Markscheme

83 (*allow whole number answers in the range of 82 to 84*)

17f. Determine the number of hours of light needed to release the maximum number of stem cells in blood in control mice. *[1 mark]*

Markscheme

5 (*allow 4*)
Do not allow answers with two different numbers.

17g. Distinguish between the trends shown in the number of stem cells per ml blood by the mice subjected to jet lag and the control mice. *[2 marks]*

Markscheme

more stem cells are formed in control / jet lag reduces the release of stem cells into blood stream / greater range in control;
graph is rhythmic in control / control has more regular pattern;
greater number of stem cells produced in light period in control, whereas greater number in dark period in jet lag;
graph is shifted to the right in jet lag / stem cells are released later in time in jet lag;

17h. Other studies suggest that a greater number of blood stem cells for transplantation may be obtained if they are harvested during darkness. Evaluate this hypothesis. *[2 marks]*

Markscheme

(hypothesis supported in control) if stem cells are harvested towards the end of the dark period / (hypothesis supported) as stem cells start increasing in dark period;
(hypothesis not supported) <u>in control</u> as peak of stem cells occurs during light period/lowest number during dark period;
(hypothesis supported) if patient is jet-lagged as more stem cells are produced in dark period;

17i. Explain how the amount of mRNA for CXCL12 gives an indication of the amount of protein CXCL12 produced. *[1 mark]*

Markscheme

mRNA is translated to protein / involved in protein synthesis.

17j. Compare the effect of isoprenaline and clenbuterol with the normal release of stem cells and the production of mRNA for CXCL12. *[3 marks]*

Markscheme

clenbuterol and isoprenaline both produce more stem cells than control;
clenbuterol releases fewer stem cells than isoprenaline / isoprenaline releases the most stem cells;
isoprenaline produces the least mRNA for CXCL12;
clenbuterol produces the same amount of mRNA for CXCL12 as control;

18a. Predict the genotypic and phenotypic ratios of the possible offspring of a male hemophiliac and a female carrier using suitable symbols for the alleles in a Punnett grid. *[3 marks]*

Genotypic ratio:

Phenotypic ratio:

Markscheme

correctly constructed Punnett square with correct gamete genotypes;

e.g.

(male gametes) \ (female gametes)	X^H	X^h
X^h	X^HX^h	X^hX^h
Y	X^HY	X^hY

genotypic ratio: 1 X^HX^h : 1X^hX^h : 1 X^HY : 1 X^hY; (can be inferred from cells of Punnett square)

phenotypic ratio: 1 female hemophiliac : 1 female carrier/non-hemophiliac :
1 male hemophiliac : 1 male normal/non-hemophiliac / 50 % hemophiliac :
50 % non-hemophiliac;

*Allow ECF. Award **[2 max]** if notation used does not indicate sex linkage, i.e. if cross is Hh×hh.*

18b. Hemophilia is a disorder where the ability to control blood clotting or coagulation is impaired. Describe the process of blood clotting. *[2 marks]*

Markscheme

release of clotting factors from platelets/damaged cells;
conversion of prothrombin to thrombin;
thrombin catalyses the conversion of fibrinogen into fibrin;
(insoluble) fibrin (net) captures blood cells;

19a. Draw a labelled diagram of a sarcomere. *[3 marks]*

Markscheme

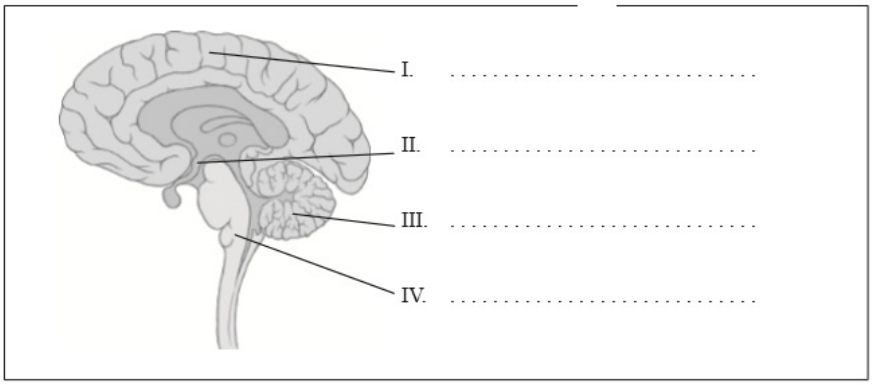
*Award **[1]** for each structure clearly drawn and correctly labelled.*
Z lines;
actin filaments;
myosin filaments with heads;
light bands and dark bands;

19b. Explain the role of calcium ions in muscle contraction. *[2 marks]*

Markscheme

Ca^{2+} ions released when a nerve impulse arrives at the muscle;
Ca^{2+} ions are released from the sarcoplasmic reticulum;
binding sites for myosin heads are exposed;
this allows cross-bridges between myosin and actin to form;

20a. Identify the parts of the brain indicated on the diagram below. *[2 marks]*



Patrick J. Lynch, medical illustrator; C. Carl Jaffe, MD, cardiologist

Markscheme

I. cerebral hemisphere / cerebrum;
II. hypothalamus;
III. cerebellum;
IV. medulla oblongata;
Award [1] for any two of the above.

20b. Outline the unconscious control of the heart rate. *[3 marks]*

Markscheme

heart can contract without nervous stimulation/myogenic contractions;
SA node is pacemaker/generates heart beat/initiates each cardiac cycle;
epinephrine/adrenalin speeds up the heart rate;
autonomic/sympathetic and parasympathetic nervous system control;
sympathetic speeds up heart rate;
parasympathetic/vagus nerve slows heart rate (back to normal/resting rate);

20c. Describe different aspects of the processing of visual stimuli. *[3 marks]*

Markscheme

edge enhancement is greater perception at edges of light/dark areas;
caused by processing in two types of ganglion cell in retina;

contralateral is processing left field of view in right side of brain / *vice versa*;
cross over between left and right sides in the optic chiasma;

convergence is combining impulses from groups of (rod/cone) cells;
done by bipolar cells in retina;

21a. List **two** functions of membrane proteins. *[2 marks]*

Markscheme

a. hormone binding sites / receptors;

b. (immobilized) enzymes;

c. cell adhesion;

d. cell (to cell) communication;

e. passive transport/channels;

f. active transport/pumps;

g. facilitate diffusion;

h. carry electrons;

21b. Explain why digestion of large food molecules is essential. *[1 mark]*

Markscheme

a. many molecules are too large to be absorbed (by the villi) / small molecules are soluble and can be absorbed;

b. large food molecules are broken down so they can be reorganized/rearranged;

21c. Outline why antibiotics are effective against bacteria but not against viruses. *[2 marks]*

Markscheme

a. antibiotics block/inhibit specific metabolic pathways/cell functions found in bacteria;

Accept specific examples of inhibition such as cell protein synthesis, cell wall formation

b. viruses must use host/eukaryotic cell metabolism / viruses do not have their own metabolic pathways;

c. host/eukaryotic cell metabolism/pathways not blocked/inhibited by antibiotics;

21d. Outline the use of polymerase chain reaction (PCR) to copy and amplify minute quantities of DNA. *[2 marks]*

Markscheme

a. strands of DNA (fragments) split/denatured with heat;

b. complementary nucleotides added to split stands (when cooling);

c. with the use of (DNA) polymerase (and primers);

d. process/heating and cooling cycle is repeated (until enough DNA is obtained);

Accept example of PCR application e.g. paternity cases or forensic investigations.

22a. State **four** molecules transported by the blood. *[4 marks]*

Markscheme

a. example of a nutrient *e.g. glucose*;

b. oxygen/O_2;

c. carbon dioxide/CO_2;

d. nitrogen/N_2;

e. hormones;

f. antibodies;

g. urea;

22b. Outline the control of the heartbeat. *[6 marks]*

Markscheme

a. is myogenic;

b. pacemaker / SA node / *OWTTE*;

c. stimulates atria to contract;

d. leading to contraction of ventricles;

e. (autonomic) nerves can alter the pace;

f. (by secretion of) epinephrine/adrenaline/norepinephrine/noradrenaline increase the pace;

g. (by secretion of) acetylcholine reduces the pace;

h. adrenal glands release epinephrine/adrenaline;

i. carried by blood to heart;

j. to increase pace;

22c. Discuss the cause, transmission and social implications of AIDS. *[8 marks]*

Markscheme

cause: [4 max]

a. AIDS caused by HIV;

b. penetrates (T) lymphocytes;

c. (envelope) (glyco)protein and cell receptors involved;

d. reverse transcriptase enables DNA to be produced from viral RNA; *(reject DNA transformed into RNA)*

e. number of lymphocytes reduced over years;

f. results in lower immunity;

g. other illnesses develop (as result of lower immunity);

h. AIDS is the observed syndrome when final stages of infection develop / *OWTTE*;

transmission: [3 max]

i. HIV transmitted through blood/sexual contact/body fluids/placenta/childbirth/ breastfeeding;

j. distribution/transmission uneven around the world;

k. transmission risk increased depending on society's traditions/beliefs/behaviour;

l. (rare minority of) individuals do not have cell receptors and do not develop AIDS;

m. condoms/latex barriers only protection against transmission through sexual contact;

social implications: [3 max]

n. treatment expensive;

o. discrimination against victims;

p. moral obligation of wealthy countries to help poorer countries;

q. economic consequences / loss of wage earners *etc.*;

r. increase in the number of orphans;

s. comment on traditions/beliefs/behaviour; *(if not already awarded in transmission) [8 max]*

23a. State which variety of rice fails to respond to gibberellin treatment. *[1 mark]*

Markscheme

gid1-1

23b. The activity of α-amylase was tested at successive concentrations of gibberellin. Determine the increment in gibberellin concentration that produces the greatest change in α-amylase activity in wild-type rice plants (WT). *[1 mark]*

Markscheme

between 10^{-8} and 10^{-7} mol dm^{-3} *(units required)*

23c. Discuss the consequence of crossing *gid1-1* heterozygous rice plants amongst themselves for food production. *[3 marks]*

Markscheme

a. 25% / 1 in 4 / 1:3 seeds produced would be homozygous recessive;

b. no response to/inhibits gibberellin in homozygous recessives results in less germination;

c. less growth / dwarf plants produced; *(must be in context)*;

d. would produce plants with infertile flowers that cannot produce rice grains;

e. would lower rice production/less yield because infertile plants cannot produce seeds (that humans can eat);

23d. Determine which gene produced the most mRNA on the first day of the submergence period for variety *O. sativa japonica*. *[1 mark]*

Markscheme

Sub1C

23e. Outline the difference in mRNA production for the three genes during the submergence period for variety *O. sativa indica*. *[2 marks]*

Markscheme

a. *Sub1A* is expressed strongly/the most / *Sub1A* produces the most RNA;

b. *Sub1B* (always) has the lowest expression/produces least mRNA;

c. *Sub1A* expressed/produces mRNA for the longest time/days 1 to 10;

d. *Sub1C* expressed/produces mRNA for the shortest time/days 3 to 7;

23f. Using only this data, deduce which gene confers submersion resistance to rice plants. *[2 marks]*

Markscheme

a. *Sub1A*;

b. is only expressed in *indica* / *Sub1B* and *SubC* are expressed in both rice varieties;

c. *indica* is the variety showing submersion tolerance / vice versa for *japonica*;

23g. State the overall effect of overexpression of the *OsGI* gene in plants treated with short-day light. *[1 mark]*

Markscheme

it increases the length of time before flowering

23h. Compare the results between the plants treated with short-day light and the plants treated with long-day light. *[2 marks]*

Markscheme

a. long-day light exposure increases time before flowering only if (*OsGI*) gene is not overexpressed/in WT and –/–;

b. long-day light exposure decreases time before flowering for +/– and/or +/+;

c. length of day does not make much difference/makes least difference for +/+;

d. overexpression for +/– reduces time before flowering;

e. –/– acts as a control / has nearly the same length of time before flowering as WT;

Accept numerical answers if they are making a clear comparison.

23i. State, giving **one** reason taken from the data opposite, if unmodified rice is a short-day plant **or** a long-day plant. *[1 mark]*

Markscheme

is a short-day plant because WT has shortest time/shorter time before flowering in shorter days than longer days / as it takes less time to flower under short day conditions;

23j. Evaluate, using all the data, how modified varieties of rice could be used to overcome food shortages in some countries. *[2 marks]*

Markscheme

a. the mutant *gid1-1* would not be useful because it produces sterile plants;

b. genetically modified rice/rice with *Sub1A* is more tolerant to submersion/can withstand seasonal flooding/torrential rain;

c. *OsGI*+ varieties adapted to different latitudes / day length could be produced (to overcome food shortages);

d. short flowering time possibly means more crops per year;

24a. Define the term *passive immunity*. *[1 mark]*

Markscheme

the acquisition of antibodies from another organism

24b. State **one** use of monoclonal antibodies in diagnosis. *[1 mark]*

Markscheme

An example, *e.g. detection of (antibodies to) HIV (reject AIDS) / isoenzyme in heart attack / (HCG in) pregnancy test kits / blood and tissue typing / detection of malarial parasites*

Accept any other valid examples.

24c. Define the term *pathogen*. *[1 mark]*

Markscheme

an organism/virus that causes a disease

Outline why antibiotics are effective against bacteria but not against viruses.

24d. *[2 marks]*

Markscheme

a. antibiotics block/inhibit specific metabolic pathways/cell functions found in bacteria;

Accept specific examples of inhibition such as cell protein synthesis, cell wall formation.

b. viruses must use host/eukaryotic cell metabolism / viruses do not have their own metabolic pathways;

c. host/eukaryotic cell metabolism/pathways not blocked/inhibited by antibiotics;

25a. Draw a labelled diagram of a mature sperm cell. *[4 marks]*

Markscheme

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

a. head and midpiece/mid-section/body;

b. tail/flagellum; *(at least four times length of the head and containing fibres)*

c. acrosome; *(shown as distinct structure near front of head)*

d. nucleus; *(occupying more than half the width or length of head)*

e. mitochondria; *(as repetitive structures inside membrane of mid piece)*

f. centriole; *(between head and midpiece)*

g. (plasma) membrane; *(shown as single line covering whole cell)*

h. microtubules; *(in 9 plus 2 array)*

25b. Outline the role of hormones in the menstrual cycle. *[6 marks]*

Markscheme

a. FSH promotes development of a new follicle;

b. also leads to the production of estrogen;

c. estrogen brings about repair and growth of uterine wall;

d. estrogen causes negative feedback of FSH;

e. estrogen brings about LH production;

f. LH stimulates follicle growth;

g. LH triggers ovulation;

h. estrogen contributes to the proliferative phase of the uterine cycle / triggers LH surge;

i. progesterone contributes to the secretory phase of the uterine cycle/maintains uterus wall;

j. lowered level of progesterone (due to degeneration of corpus luteum) leads to menstruation;

25c. Discuss the cause, transmission and social implications of AIDS. *[8 marks]*

Markscheme

cause: [4 max]

a. AIDS caused by HIV;

b. penetrates (T) lymphocytes;

c. (envelope) (glyco)protein and cell receptors involved;

d. reverse transcriptase enables DNA to be produced from viral RNA; *(reject DNA transformed into RNA)*

e. number of lymphocytes reduced over years;

f. results in lower immunity;

g. other illnesses develop (as result of lower immunity);

h. AIDS is the observed syndrome when final stages of infection develop / *OWTTE*;

transmission: [3 max]

i. HIV transmitted through blood/sexual contact/body fluids/placenta/childbirth/ breastfeeding;

j. distribution/transmission uneven around the world;

k. transmission risk increased depending on society's traditions/beliefs/behaviour;

l. (rare minority of) individuals do not have cell receptors and do not develop AIDS;

m. condoms/latex barriers only protection against transmission through sexual contact;

social implications: [3 max]

n. treatment expensive;

o. discrimination against victims;

p. moral obligation of wealthy countries to help poorer countries;

q. economic consequences / loss of wage earners etc.;

r. increase in the number of orphans;

s. comment on traditions/beliefs/behaviour; *(if not already awarded in transmission) [8 max]*

26a. Calculate the percentage risk of bacteria becoming resistant to more than five kinds of antibiotics in turkeys and egg laying hens. *[1 mark]*

Turkeys:

Egg laying hens:

Markscheme

turkeys: 33/32.6/32.56 %

egg laying hens: 0 %

Both needed to award the mark.

26b. Compare the incidence of drug resistance in bacteria from chickens and egg laying hens. *[2 marks]*

Markscheme

a. none of the egg laying hens have bacteria resistant to 5 or more antibiotics while (10) chickens have bacteria resistant to 5 or more antibiotics;

b. 13/65 % of the egg laying hens have no resistant bacteria while 9/20 % of the chickens have no resistant bacteria;

c. both have approximately same percentage/number of *E. coli* resistant to 1 or 3 antibiotics;

d. egg laying hens have less incidence of antibiotic-resistant bacteria than chickens;

Discuss the hypothesis that giving antibiotics increases antibiotic resistance in poultry bacteria.

26c. *[2 marks]*

Markscheme

a. hypothesis supported for poultry raised for meat but not for egg-laying;

b. turkeys and chickens always have bacteria resistant to more antibiotics than egg laying hens;

c. antibiotic-resistant bacteria are still found in egg laying hens even though antibiotics are rarely given;

d. antibiotic-resistant strains (of bacteria) may have arisen by other means/other than by poultry being given oral antibiotics;

26d. Suggest how antibiotic-resistant bacteria are passed from animals to humans. *[1 mark]*

Markscheme

from fecal matter to man handling the chickens / by accidental hand to mouth contact / contaminated dust / eating raw meat;

27a. Identify hormones I and II. *[2 marks]*

I: .....

II: .....

Markscheme

I: progesterone;
II: estrogen;

27b. Outline the roles of FSH in the menstrual cycle. *[2 marks]*

Markscheme

FSH stimulates follicle development;
FSH stimulates estrogen secretion (by the follicle/ovary);

27c. FSH is secreted by the pituitary gland. During pregnancy, FSH secretion is inhibited. Suggest how FSH secretion could be inhibited during pregnancy. *[1 mark]*

Markscheme

high levels of progesterone/estrogen inhibit FSH production (during pregnancy)