Semester two examination, 2022

Question/Answer Booklet

HUMAN BIOLOGY
UNITS 1 & 2

Name: Marking Key

Teacher: _____

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time for the paper: three hours

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Multiple-choice Answer Sheet

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: up to three calculators, which do not have the capacity to create or store programmes or text, are permitted in this ATAR course examination

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One Multiple-choice	30	30	40	30	30
Section Two Short answer	7	7	90	108	50
Section Three Extended answer Unit 1	2	1	50	20	10
Unit 2	2	1		20	10
				Total	100

Instructions to candidates

1. The rules for the conduct of the Western Australian examinations are detailed in the *Year 12 Information Handbook 2022: Part II Examinations*. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.

3. Answer the questions according to the following instructions.

   Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

   Section Two: Write your answers in this Question/Answer booklet. Wherever possible, confine your answers to the line spaces provided.

   Section Three: Consists of two parts each with two questions. You must answer one question from each part. Tick the box next to the question you are answering. Write your answers in this Question/Answer booklet

4. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.

5. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Section One: Multiple–choice **30% (30 Marks)**

This section has **30** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable of gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 40 minutes.

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1. Follicle stimulating hormone is released from the

   (a) ovaries.
   (b) testes.
   (c) corpus luteum.
   (d) pituitary gland.

Questions 2, 3 and 4 refer to the following information.

Sahan is studying microscopy in class, using a light microscope with a 10x ocular lens to view various samples of human body cells. The first sample he observes is a slide of epithelial cells taken from the lining of the duodenum, viewed at a total magnification of 400x.

2. Which of the following objective lenses is Sahan using to view the slide of epithelial cells?

   (a) 10x
   (b) 40x
   (c) 4x
   (d) 400x

3. If one of the epithelial cells in the sample takes up approximately one fifth of the diameter of the field of view, which is 0.46 mm at this magnification, what is the approximate size of the cell in millimetres?

   (a) 92 mm
   (b) 0.092 mm
   (c) 2.3 mm
   (d) 2300 mm

4. Which of the following correctly states the diameter of the field of view, in micrometres, if the microscope was changed to 1000x total magnification?

   (a) 460 µm
   (b) 0.184 µm
   (c) 184 µm
   (d) 115 µm

5. A Pap smear is a test that can be used to identify abnormal cells that could lead to the development of

(a) cervical cancer.
(b) prostate cancer.
(c) bowel cancer.
(d) breast cancer.

6. An imbalance in the action of osteoblasts and osteoclasts can most likely lead to the onset of which of the following disorders?

(a) osteoarthritis
(b) bone cancer
(c) osteoporosis
(d) rheumatoid arthritis

7. Which of the following correctly describes the importance of informed consent when carrying out an investigation involving human trials?

(a) Everyone has the right to have their identities kept confidential.
(b) Everyone has the right to know the possible risks, potential benefits and the objectives of the investigation.
(c) Nobody should be pressured into taking part in the investigation.
(d) Everyone has the right to remain anonymous throughout the investigation.

8. After a 12-week ultrasound a young couple were informed that there was a high probability of their baby being born with a chromosomal abnormality. The couple decided to get a diagnostic test to allow them to be better informed and prepared for the outcome at birth. Which of the following tests would the couple be able to get at this week of the pregnancy?

(a) chorionic villus sampling
(b) fetoscopy
(c) preimplantation genetic testing
(d) amniocentesis

9. Athletes have an increased risk of wearing away the cartilage found on the epiphyses of the bone that allow for smooth, frictionless movement. This can lead to a condition known as

(a) rheumatoid arthritis.
(b) spondyloarthritis.
(c) osteoarthritis.
(d) bursitis.

10. Which of the following correctly describes a difference between the processes of spermatogenesis and oogenesis?

(a) Spermatogenesis produces 4 mature haploid cells while oogenesis produces 1 mature haploid cell.
(b) Spermatogenesis occurs in the interstitial cells of the testes while oogenesis occurs in the ovaries.
(c) Spermatogenesis produces 4 haploid cells while oogenesis produces 1 diploid cell.
(d) Spermatogenesis produces polar bodies while oogenesis does not.

11. The outer layer of cells that spermatozoa break through in order to enter the cytoplasm of the ovum is known as the

(a) corpus luteum.
(b) zona pellucida.
(c) acrosome.
(d) corona radiata.

12. A man with Huntington's disease and a woman without Huntington's have two children. After genetic testing it is determined that one of their children will develop Huntington's when they're older, while the other is genetically healthy. What is the percentage probability of the couple having another child with Huntington's disease?

(a) 25%
(b) 75%
(c) 50%
(d) 100%

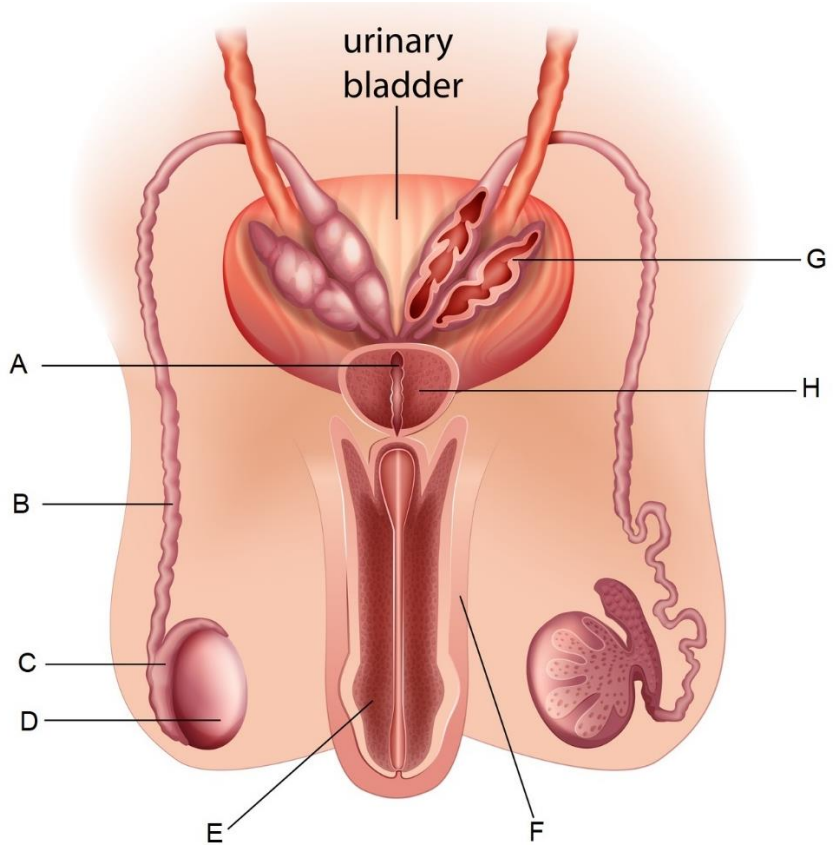
13. The following points describe the steps, out of order, in the sliding filament model that explains the contraction of skeletal muscles from the point where the muscle cells are stimulated by a nerve cell.

(i) Myosin heads bind to actin forming a myosin cross-bridge
(ii) The myosin head bends and ADP and phosphate are released, pulling the actin over the myosin
(iii) Calcium ions enter the muscle cells and the presence of calcium exposes the myosin binding sites on the actin molecule
(iv) A new molecule of ATP attaches to the myosin and the cross-bridge detaches

Which of the following indicates the steps in the correct order?

(a) (i), (ii), (iii), (iv)
(b) (iii), (i), (iv), (ii)
(c) (i), (iii), (iv), (ii)
(d) (iii), (i), (ii), (iv)

Questions 14, 15 and 16 refer to the following diagram of the human male reproductive system.



14. Which of the following labels indicates the epididymis?

(a) A
(b) B
(c) C
(d) D

15. Which of the following most correctly describes the function of the part labelled H?

(a) It secretes a fluid rich in sugars that makes up the majority of the seminal fluid.
(b) It secretes a small amount of fluid that acts as a lubricant.
(c) It secretes an alkaline fluid that helps to neutralise the acidity in the vagina.
(d) It secretes a fluid rich in proteins to provide spermatozoa with strength for swimming.

16. A relatively simple surgical procedure to sterilise males and prevent conception usually involves which of the following parts?

(a) A
(b) B
(c) C
(d) D

17. Fertilisation typically takes place in the

(a) ovaries.
(b) cervix.
(c) uterus.
(d) uterine tubes.

18. Which of the following does **not** describe a structure of the alveoli that make them suited to the process of gas exchange?

(a) The alveoli are one-cell thick.
(b) The alveoli contain approximately 21% oxygen concentration from inhaled air.
(c) The alveoli are surrounded by a rich supply of blood capillaries.
(d) The alveoli are surrounded by a thin layer of moisture.

Questions 19, 20 and 21 refer to the following information.

Deidre and Georgina are conducting an investigation to see the change in mass of cylinders of potatoes when placed in varying concentrations of sucrose solutions. They find that when the potatoes are placed in distilled water they tend to increase in mass, while those placed in concentrated sucrose solutions tend to decrease in mass.

19. Which of the following correctly identifies the dependent variable in this investigation?

(a) the concentration of sucrose
(b) the change in mass of the potato
(c) the volume of sucrose solution
(d) the final mass of the potato

20. If one cylinder of potato in a highly concentrated sucrose solution has an initial mass of 1.55 g and a final mass of 1.44 g, which of the following correctly states the percentage change in mass?

(a) 11% increase
(b) 7% increase
(c) 11% decrease
(d) 7% decrease

21. Which of the following best explains why the potatoes in distilled water increased in mass?

(a) The sucrose moved into the potato through diffusion to balance out the concentration of sucrose in the potato and the water.
(b) The water had a higher solute concentration than the potato, so the water moved into the cells of the potato through osmosis.
(c) The potato had a higher solute concentration than the distilled water, so the water moved into the cells of the potato through osmosis.
(d) The cells of the potato gained mass as the starch inside was diluted by the distilled water.

22. During the process of flexion at the knee, the hamstring is contracting and the quadriceps are relaxing. Which of the following correctly describes the relationship between these two groups of muscles during this movement?

(a) The hamstring is the agonist while the quadriceps are the antagonists.
(b) The hamstring is the antagonist while the quadriceps are the agonists.
(c) The hamstring is the synergist while the quadriceps are fixators.
(d) The hamstring is the fixator while the quadriceps are synergists.

23. Pairs of homologous chromosomes line up together at the equator during

(a) metaphase.
(b) metaphase I.
(c) metaphase II.
(d) anaphase I.

24. With regards to inheritance of ABO blood groups, which of the following correctly identifies the mode of inheritance for the allele that results in no antigens presenting on the erythrocytes?

(a) X-linked recessive
(b) X-linked dominant
(c) Autosomal dominant
(d) Autosomal recessive

25. In a healthy, functioning nephron, active reabsorption of glucose **mostly** occurs in the

(a) proximal convoluted tubule.
(b) renal corpuscle.
(c) loop of Henle.
(d) distal convoluted tubule.

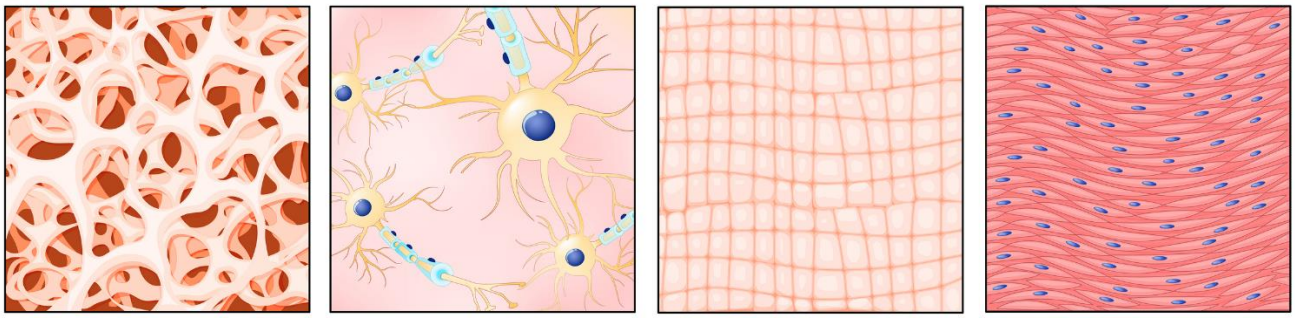
26. Glucose is a relatively large, water-soluble molecule that cells consistently use up during the process of cellular respiration. Glucose would most likely pass through the cell membrane through which of the following processes?

(a) osmosis
(b) simple diffusion
(c) facilitated diffusion
(d) active transport

27. Which of the following embryonic membranes will eventually form the foetal portion of the placenta?

(a) the chorion
(b) the amnion
(c) the yolk sac
(d) the allantois

Question 28 refers to the following diagram showing different types of tissue.



28. Which of the following correctly identifies the types of tissue, from left to right, shown in the diagram?

(a) connective, nervous, muscular, epithelial
(b) epithelial, nervous, connective, muscular
(c) epithelial, nervous, muscular, connective
(d) connective, nervous, epithelial, muscular

29. After the first meiotic division during oogenesis, one of the cells created is smaller than the other with very little cytoplasm, while the other is larger and contains most of the cytoplasm. These two cells are, respectively, referred to as the

(a) first polar body and secondary oocyte.
(b) first polar body and primary oocyte.
(c) second polar body and secondary oocyte.
(d) second polar body and primary oocyte.

30. Aaliyah has type AB negative blood type and suffers from a blood disorder which requires regular blood transfusions. Which of the following blood types would she **not** be able to receive in a transfusion?

(a) Type A negative
(b) Type B negative
(c) Type O negative
(d) Type O positive

End of Section One

Section Two: Short answer **50% (108 marks)**

Question 31 **(19 marks)**

A group of students were investigating the effect of exercise intensity on tidal volume of the lungs. They measured the tidal volume of five of their classmates at rest and then asked each individual to complete different types of exercise, increasing in levels of intensity, for 4 minutes at a time. Immediately after completing each exercise their tidal volume was then measured with a spirometer and recorded in litres (L).

The data is shown in the table below.

	Tidal volume (L) after completing 4 minutes of exercise at different intensity levels					
Type of Exercise	Individual 1	Individual 2	Individual 3	Individual 4	Individual 5	Mean
At rest	0.50	0.61	0.48	0.49	0.56	0.53
Walking	1.21	1.10	1.16	1.18	1.42	1.21
Jogging	2.25	2.23	2.18	2.04	1.98	2.14
Sprinting	2.68	2.73	2.38	2.80	2.67	2.65

(a) Outline a possible hypothesis for this investigation. (1 mark)

Description	**Marks**
Answer must be a statement clearly linking independent and dependent variable, for example:	
The more intense the exercise, the greater the tidal volume of the lungs	1
Total	**1**

(b) Identify **one** variable that was controlled during the students' investigation. (1 mark)

Description	**Marks**
Any one from:	
Length of time for each exercise/4 minutes for each exercise	1
Participants all from the same class/all participants are students	
All students measured immediately after exercise	
Total	**1**

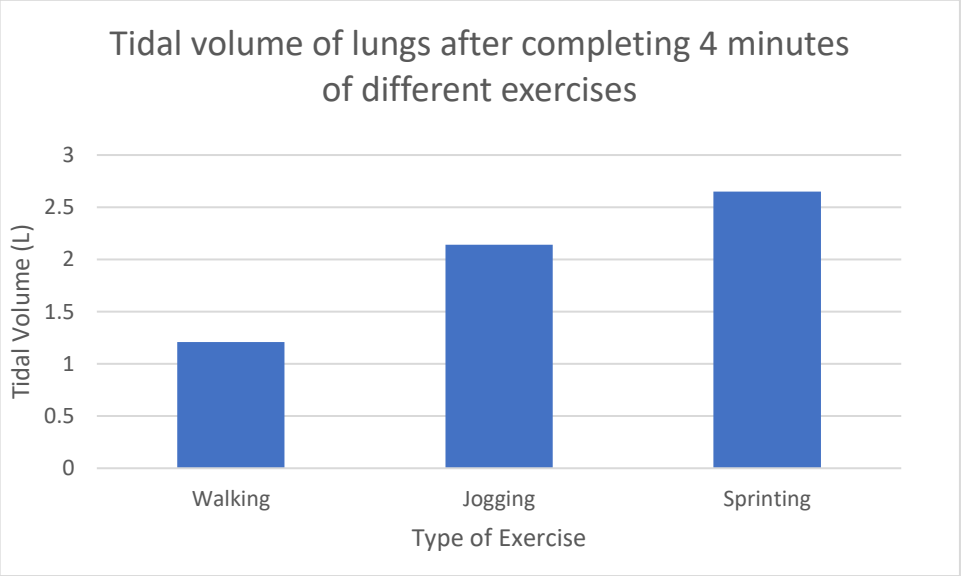
(c) Complete the table above by calculating the mean tidal volume for 'Walking'. (1 mark)

Description	**Marks**
See table for correct answer	1
Total	**1**

(d) Construct a graph of the average tidal volume for each type of exercise, **not** including the average for when the students were at rest, on the grid provided below. (5 marks)

Description	Marks
Descriptive title identifying independent and dependent variable	1
Correctly organised with tidal volume on the y-axis	1
Labelled both axes, with units identified on the y-axis	1
Appropriate scale for the y-axis	1
Correctly plotted column graph	1
Total	**5**

Example:



A spare grid is provided at the end of this Question/Answer Booklet. If you need to use it, cross out this attempt and indicate that you have redrawn it on the spare grid.

(e) Suggest and explain **one** factor that may have affected the validity of the data. (2 marks)

Description	Marks
Any relevant suggestion, with explanation linking to how it affects validity, example:	
No rest time given between each type of exercise	1
The tidal volume measured would not show the effect of each individual exercise/the tidal volume measured would represent a cumulative effect of duration of exercise on tidal volume (therefore not testing the hypothesis)	1
Total	**2**

(f) Tidal volume can be defined as the amount of air moved into the lungs during the process of inspiration. Describe the process of inspiration. (4 marks)

Description	Marks
Diaphragm contracts and flattens	1
Intercostal muscles contract and pull ribs up and out	1
This increases the volume in the chest cavity, and decreases the pressure	1
Air enters the lungs moving from high to low pressure	1
Total	**4**

The students knew that an increase in the intensity of exercise causes an increase in contractions of the skeletal muscles, which requires the production of adenosine triphosphate (ATP).

(g) State **one** chemical processes that occurs during cellular respiration in the muscle cells that results in the production of ATP. (1 mark)

Description	Marks
Any one from:	
Glycolysis	1
Krebs cycle/citric acid cycle	
Electron transport system/oxidative phosphorylation	
Total	**1**

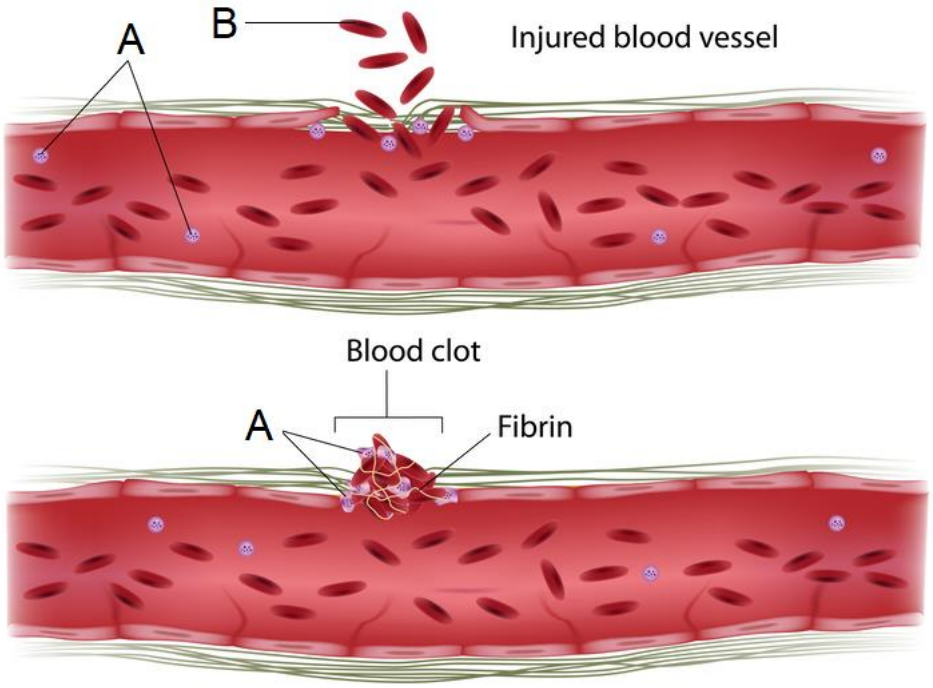
The students were able to infer, from their scientific knowledge, that the increase in the tidal volume of the lungs during exercise will increase the rate of gas exchange between the blood in the capillaries and the air in the alveoli.

(h) Explain why there would be an increase in the rate of gas exchange as the skeletal muscles start working harder. (4 marks)

Description	Marks
Increase in gas exchange would increase amount of oxygen entering the blood	1-4
While increasing the amount of carbon dioxide leaving the body/blood	
Oxygen is needed for cellular respiration/to produce ATP (for working muscles)	
Carbon dioxide is produced from cellular respiration, so more needs to be excreted from the lungs during exercise	
Blood vessels would dilate, allowing more CO_2 to be removed and more O_2 delivered	
Increase in pulmonary circulation/increase of blood flow to the lungs, bringing more CO_2 to the lungs (to maintain concentration gradient)	
Total	**4**

Question 32 **(12 marks)**

The diagram below represents a simplified view of the formation of a blood clot after a blood vessel has been damaged.



(a) Name of the blood cells labelled 'A' and 'B' in the diagram. (2 marks)

Description	Marks
A – platelets/thrombocytes	1
B – red blood cells/erythrocytes	1
Total	**2**

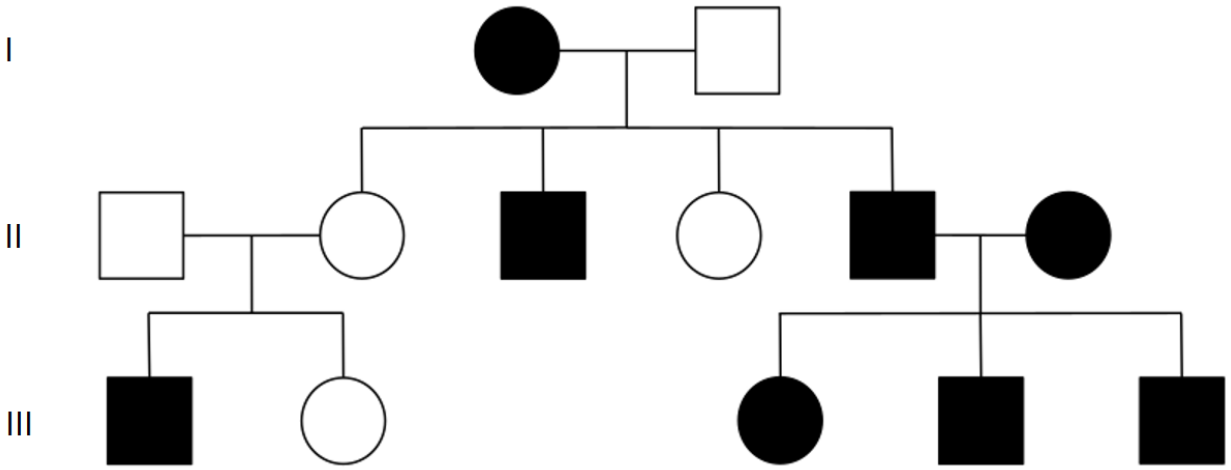
A broken blood vessel can lead to an infection of foreign microorganisms. This can stimulate a specific type of blood cell, known as a neutrophil, to consume the microorganisms through phagocytosis, a special form of endocytosis.

(b) Describe the process by which the neutrophil consumes invading microorganisms. (2 marks)

Description	Marks
Cell membrane folds around the microorganism (in the extracellular fluid)	1
This encloses the microorganism in a vesicle (now in the cytoplasm of the cell)	1
Total	**2**

The X-linked genetic condition known as haemophilia means that people are unable to produce certain clotting factors that result in the production of the meshwork of protein fibres known as fibrin.

The pedigree chart below shows the inheritance of haemophilia in a family.



(c) State whether haemophilia is dominant or recessive. Justify your answer using evidence from the pedigree. (2 marks)

Description	Marks
Recessive	1
Individual 1 and 2 in generation II are unaffected, but have an affected son/the unaffected mother in generation II has an affected son	1
Total	**2**

(d) Using the letters **N** and **n**, state the genotypes of individual II-2 and II-3. (2 marks)

Description	Marks
II-2 – X^NX^n	1
II-3 – X^nY	1
Total	**2**

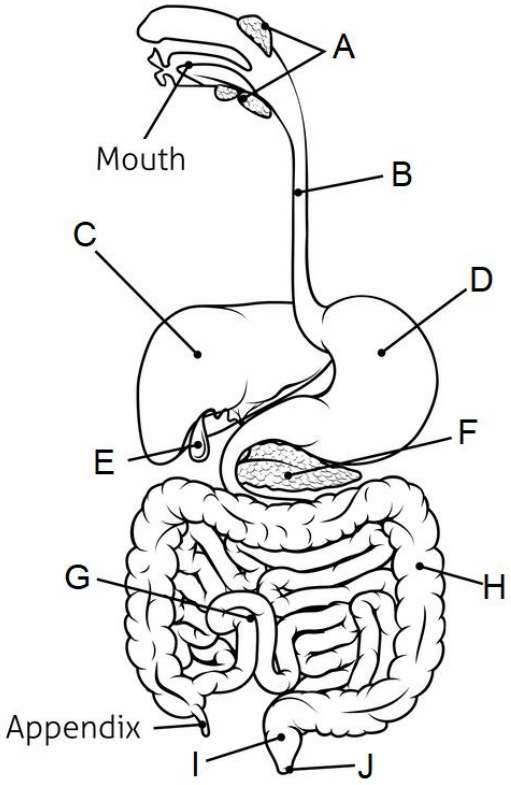
(e) Is it possible for the two individuals in generation I to have a son **without** haemophilia? Explain your answer. (You may use a Punnett square as part of your explanation).

(4 marks)

<table>
<tr><th>Description</th><th>Marks</th></tr>
<tr><td>No</td><td>1</td></tr>
<tr><td>The son will receive the X chromosome from the mother, who is homozygous recessive for haemophilia/who has two recessive alleles for haemophilia</td><td rowspan="4">1-3</td></tr>
<tr><td>and will receive Y chromosome from the father, which will not carry any alleles</td></tr>
<tr><td>Therefore, will always be hemizygous for haemophilia/always inherit the haemophilia allele but cannot mask its effects</td></tr>
<tr><td>Correct Punnett square showing 100% inheritance of recessive allele by males, see example:
<table>
<tr><td></td><td>X^n</td><td>X^n</td></tr>
<tr><td>X^N</td><td>X^NX^n</td><td>X^NX^n</td></tr>
<tr><td>Y</td><td>X^nY</td><td>X^nY</td></tr>
</table>
All males affected by recessive allele</td></tr>
<tr><td>Total</td><td>4</td></tr>
</table>

Question 33 **(17 marks)**

The diagram below shows the structures found in the human digestive system.



(a) Complete the table below based on the diagram given. (3 marks)

Description	Marks
A – salivary glands	1
B – oesophagus	1
E – gall bladder	1
Total	**3**

(b) The structure labelled C also plays an important role in metabolic pathways linked to excretion. Name and briefly describe/outline the process that takes place in structure C that leads to the production of urea, a substance excreted by the kidneys. (3 marks)

Description	Marks
Deamination	1
An amino group (NH_2) is removed from an amino acid, resulting in the production of ammonia	1
Ammonia is converted into (less toxic) urea	1
Total	**3**

Pancreatic cancer is a type of cancer which can result in the disruption of the normal functioning of the pancreas, which plays an important role in chemical digestion.

(c) Contrast mechanical and chemical digestive processes. (3 marks)

Description	Marks
Any three of the following contrasting points	
Mechanical digestion breaks food into smaller pieces, chemical breaks large molecules into smaller molecules	1-3
Mechanical digestion increases surface area of food, chemical digestion does not	
Mechanical digestion doesn't use enzymes, chemical digestion does	
Mechanical digestion involves physical movements, chemical digestion does not	
Mechanical digestion doesn't change chemical composition, chemical digestion does	
Total	**3**

(d) State which label on the diagram correctly identifies the pancreas. (1 mark)

Description	Marks
F	1
Total	**1**

(e) Describe what cancer refers to, and explain how the growth of a tumour due to cancer could disrupt the normal functioning of an organ. (3 marks)

Description	Marks
Cancer refers to when cells divide uncontrollably/cancer is uncontrolled growth of abnormal cells	1
Cancer cells do not develop into normal tissue cells	1
These cancer cells will use up resources/'take the place' of the normal cells and inhibit their normal functioning	1
Total	**3**

(f) Pancreatic cancer can lead to, among other things:

Malabsorption – a difficulty in absorbing essential nutrients, and;
Malnutrition – where the cells do not receive enough essential nutrients.

Explain how a dysfunction of the pancreas can cause these conditions. (4 marks)

Description	Marks
The pancreas produces a number of enzymes (essential for chemical digestion)	1
If the pancreas is not working then the pancreatic enzymes will not be will be released/their production will be slowed which leads to less chemical digestion	1
Less chemical digestion means nutrients may not be broken down into small enough molecules to be absorbed (therefore malabsorption)	1
this means less nutrients are in the bloodstream so less nutrients reach the cells (therefore malnutrition)	1
Total	**4**

Question 34 **(17 marks)**

Proteins are one of the essential nutrients required for the normal functioning of cells and therefore the normal functioning of the entire human body. The production of specialised proteins called enzymes, among other things, also allows for the synthesis of other essential nutrients such as lipids and carbohydrates.

Protein synthesis is a complex process that can be divided into two stages – transcription and translation.

(a) State the name of the cell organelles where each of the stages of protein synthesis takes place. (2 marks)

Description	Marks
Transcription - nucleus	1
Translation - ribosomes	1
Total	**2**

(b) Outline the basic structure of proteins. (2 marks)

Description	Marks
Made up of long chains of amino acids	1
Bonded together with peptide bonds	1
Total	**2**

(c) Describe the process of transcription. (5 marks)

Description	Marks
DNA in the nucleus comes apart (due to RNA polymerase/helicase)	
Reveals a template strand and coding strand (that are complementary to each other)	
RNA polymerase transcribes the template strand of DNA	
Using free floating RNA nucleotides to build mRNA	
mRNA is made up of the complement of the template strand except for uracil where there would normally be thymine	
A specific sequence of bases/stop codon tells RNA polymerase to stop copying when mRNA is finished building	
Total	**5**

Errors in the DNA code can lead to problems with protein synthesis, which can have a range of effects on normal cell functioning.

(d) Explain the possible effect on metabolism if the enzymes needed for carbohydrate production could not be produced. (3 marks)

Description	Marks
Carbohydrates are an important energy source/are used in cellular respiration	1
Without the enzymes less carbohydrates would be produced	1
Therefore less energy is released and metabolism will slow	1
Total	**3**

One genetic disorder that can affect protein production is an autosomal, recessive condition known as phenylketonuria (PKU). This condition leads to a deficiency of an enzyme responsible for the breakdown of an amino acid called phenylalanine.

(e) Describe what is meant by an autosomal, recessive genetic condition. (2 marks)

Description	Marks
The allele is found on the autosomes/not found on the sex chromosomes	1
It can be masked by a dominant allele/doesn't show unless there are two copies of the allele	1
Total	**2**

(f) Determine the probability of two individuals whom are heterozygous for the recessive PKU allele having a child with the genetic condition. Show your working. (3 marks)

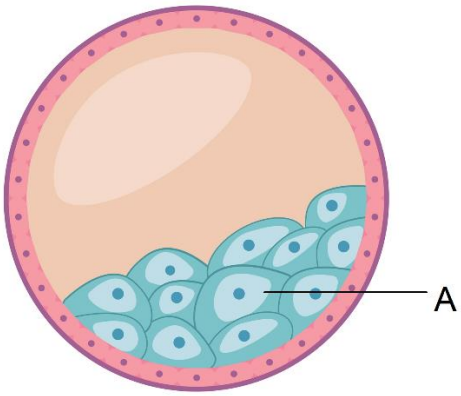
Description	Marks
Correct genotypes of parents	1
Correctly filled out Punnett square	1
Correct probability of PKU	1
Example of working:	
Total	**3**

	N	n
N	NN	Nn
n	Nn	**nn**

25% chance of having a child with PKU

Question 35 **(16 marks)**

The diagram below shows a cross-section of a blastocyst, a structure formed within 5-6 days after fertilisation takes place.



The part labelled A is a group of stem cells that will differentiate into all of the body cells that form the embryo.

(a) State the name given to the group of cells labelled 'A'. (1 mark)

Description	Marks
Inner cell mass/embryoblast	1
Total	**1**

(b) The stem cells in part 'A' will initially differentiate into three layers known as the embryonic germ layers. Name **two** of these layers and identify one system, organ or tissue type that each layer can differentiate into. (4 marks)

Description	Marks
Any two of the following, 1 mark for naming layer and 1 mark for correctly identifying system/organ/tissue:	
Ectoderm Skin/hair/mammary glands/nervous system	1-2
Mesoderm Skeleton/muscles/connective tissue/heart/blood/stomach/urinary system	1-2
Endoderm Digestive system/lungs/respiratory system/thyroid	1-2
Total	**4**

(c) Name and contrast the potency of the stem cells found in part 'A' compared to adult stem cells, such as those that are found in the red bone marrow. (4 marks)

Description	Marks
Pluripotent in inner cell mass/part 'A'	1
Multipotent in red bone marrow/adult stem cells	1
Pluripotent can differentiate into any cell of the human body	1
Multipotent can only differentiate into specific types of cells/groups of cells (e.g. the blood cells)	1
Total	**4**

Differentiation of stem cells occurs because of signals that influence gene expression, leading to cell specialisation. The study of the external factors that can affect gene expression is known as epigenetics.

(d) One way in which gene expression is regulated through epigenetics is due to changes in chromatin.

(i) Describe the structure of chromatin. (1 mark)

Description	Marks
DNA molecule wrapped around histones	1
Total	**1**

(ii) Name and describe **one** epigenetic factor that can alter chromatin and state the effect this factor has on gene expression. (3 marks)

Description	Marks
One of the following, 1 mark for name, 1 for description and 1 mark for effect on gene expression	
Acetylation An acetyl group attaches to the histone protein This enhances gene expression	1-3
Methylation Methyl group attaches to DNA/CpG site on DNA This inhibits gene expression	1-3
Total	**3**

Stem cells not only have the ability to differentiate into specialised cells, but they can also repeatedly divide by mitosis to form more stem cells.

(e) Outline the major events that occur in the following phases of mitosis.

(i) Metaphase (1 mark)

Description	Marks
Chromosomes line up at the equator of the cell	1
Total	**1**

(ii) Anaphase (2 marks)

Description	Marks
Pairs of (sister) chromatids are separated at the centromere	1
and they are pulled towards opposite poles of the cell	1
Total	**2**

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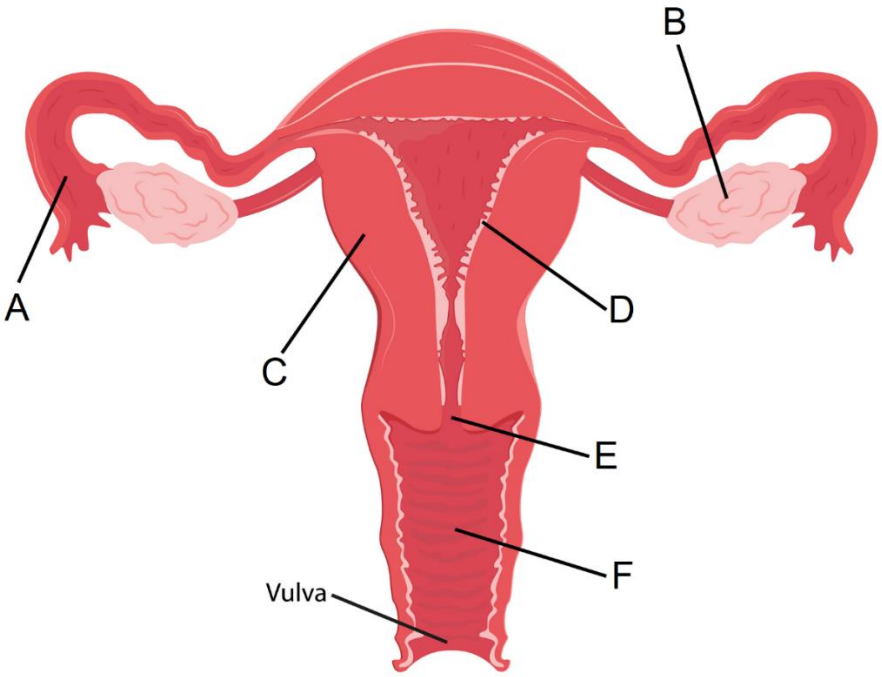
Question 36 **(13 marks)**

The diagram below shows the structures of the female reproductive system.



(a) Complete the table below, outlining the function of the structures indicated. (2 marks)

Description	Marks
B – produces ova/oestrogen/progesterone	1
D – (thickens/becomes more vascular) allows for zygote/blastocyst/embryo to implant/to maintain pregnancy if implantation occurs/is shed during menstruation if pregnancy doesn't occur	1
Total	**2**

Gonorrhoea is a sexually transmitted infection (STI) that, if left untreated, can lead to blockages in the structure labelled 'A' in the diagram, and therefore infertility problems.

(b) Identify whether gonorrhoea is a viral or bacterial infection, and state the normal treatment for this STI. (2 marks)

Description	Marks
Bacterial	1
Through the use of antibiotics	1
Total	**2**

(c) Suggest **one** way in which a gonorrhoea infection could be prevented. (1 mark)

Description	Marks
Abstinence/use of condom/female condom/femidom/limit number of sexual partners/test for STI prior to intercourse	1
Total	**1**

(d) Explain how a blockage in structure 'A' could lead to infertility and state **one** other STI that could cause infertility in females. (4 marks)

Description	Marks
The egg/secondary oocyte is normally released into 'A'/the fallopian tube where it is fertilised/the zygote travels through the fallopian tube to reach the uterus	1
If blocked, the sperm cannot reach the egg/secondary oocyte for fertilisation/the fertilised egg cannot reach the uterus	1
Therefore, conception cannot occur/implantation cannot occur which means a woman is unable to fall pregnant (=infertility)	1
Chlamydia	1
Total	**4**

(e) Name and explain **one** form of assisted reproductive technology (ART) that could **best** help overcome the fertility problems caused by a gonorrhoea infection. (4 marks)

Description	Marks
In-vitro fertilisation/IVF	1
Sperm and egg are mixed in a lab/suitable environment where fertilisation can occur	1
Fertilised egg/blastocyst is inserted directly into uterus	1
This works against infertility due to gonorrhoea because doesn't need to pass through the fallopian tube, bypassing the problem	1
or:	
Intracytoplasmic sperm injection/ICSI	1
Viable sperm is directly inserted into viable egg where fertilisation occurs outside the body/in a lab	1
Fertilised egg/blastocyst is inserted directly into uterus	1
This works against infertility due to gonorrhoea because doesn't need to pass through the fallopian tube, bypassing the problem	1
Total	**4**

Question 37 **(14 marks)**

Parturition, or birth, is the point where the foetus is expelled from the woman's body. After the birthing process there are a number of changes that occur in the circulatory system of the newborn.

(a) The birth process is typically divided into three stages of labour. Outline any **two** processes/events that occur in each stage of labour. (6 marks)

Description	Marks
First stage (any two): The cervix is shortened The cervix dilates Contractions of the uterus become more regular/occur at regular intervals Foetus moves more deeply into the pelvis Formation of a single, curved passage (birth canal)	1-2
Second stage (any two): Amnion bursts and amniotic fluid is released Contraction of the abdominal muscles occurs The baby's head turns to face the mother's back Crowning occurs Once head emerges, baby rotates its head towards mother's hips Foetus is expelled from the uterus/delivery of the foetus	1-2
Third stage (any two): The umbilical cord is clamped in two places and cut The uterus continues to contract forcing out the afterbirth Uterus contractions squeeze shut the blood vessels (to prevent loss of blood)	1-2
Total	**6**

The foramen ovale is an opening between the two atria that is present in the foetal heart. It provides the blood with a different pathway compared to normal circulation through the heart.

(b) Name and describe the function of **two other** structures found in the circulatory system of a foetus compared to a newborn baby. (4 marks)

Description	Marks
Ductus arteriosus	1
Directs blood away from the lungs to flow directly into the aorta	1
Ductus venosus	1
Directs blood away from the liver into the inferior vena cava	1
Total	**4**

The foramen ovale usually closes shortly after the baby is born, however there are cases when the opening does not close properly.

(c) Explain the effect on normal blood flow through the heart if the foramen ovale fails to close at birth and suggest **one** possible symptom if this were to occur. (4 marks)

Description	Marks
A lot of blood would **not** pass into the pulmonary artery	1
Therefore less blood would reach the lungs	1
and blood would not gain enough oxygen (and release carbon dioxide)	1
Leads to a state of hypoxia/possible fatigue/shortness of breath/other relevant symptom	1
Total	**4**

End of Section Two

Section Three: Extended answer **20% (40 Marks)**

Unit 1

Question 38 **(20 marks)**

To allow for efficient metabolism, cells require a constant supply of nutrients and oxygen, and need to constantly remove metabolic wastes.

(a) Explain how surface area to volume ratio, concentration gradients and the physical and chemical nature of substances can affect the exchange of materials across the cell membrane. (10 marks)

Description	Marks
Surface area to volume ratio:	
Cells are very small, which gives them a large surface area compared to volume	1
This means that the cell can efficiently exchange enough materials through the cell membrane to support its given volume/if the cell was larger it could not supply its given volume with enough materials through the cell membrane	1
Concentration gradients:	
A concentration gradient refers to a difference in concentration across the cell membrane	1-3
Substances tend to passively move down a concentration gradient/from areas of high to areas of low concentration	
If the concentration gradient across the membrane is maintained this allows for constant exchange of materials across the cell membrane	
The greater the concentration gradient, the faster exchange of materials (or opposite concept)	
Physical nature:	
Some molecules are larger than others, which affects their ability to pass through the small spaces in the membrane	1
Small molecules can travel directly through the lipid membrane while larger molecules cannot fit/need to pass through carrier or channel proteins	1
Chemical nature:	
The cell membrane is made up of lipids/a phospholipid bilayer	1
Therefore lipid-soluble/non-polar molecules can easily diffuse through the lipid portions of the membrane (because they are not repelled by the lipid portion of the membrane)	1
Water soluble/polar molecules cannot pass through and need to use carrier/channel proteins to cross the membrane (because they are repelled by the lipid portion of the membrane)	1
Total	**10**

Enzymes are specialised proteins that help cells to maintain efficient metabolism. They work best in an optimum temperature between 30 to 40°C.

(b) Describe how enzymes function to optimise metabolism in the cells and explain the effect an increase in body temperature from 37°C to above 40°C can have on normal enzyme function.

(10 marks)

Description	Marks
How enzymes function:	
They can attach to a specific substrate	1-6
The active site of the enzyme will combine with the substrate	
Form an enzyme-substrate complex (before a chemical reaction occurs)	
Can work based on lock and key model/induced fit model	
Enzymes act as (organic/biological) catalysts	
To speed up the rate of chemical reactions in the cell	
By reducing the activation energy/reducing the energy needed to get a chemical reaction started	
They are not used up/altered in the reaction themselves and can be reused	
Effect of temperature on enzyme function:	
The rate of reaction will initially increase as temperature increases	1
As the temperature reaches above 40°C the enzyme/active site becomes denatured	1
This changes the shape of the enzyme	1
Therefore the enzyme cannot combine with the substrate and the reaction cannot be carried out/the enzyme cannot function as normal	1
Total	**10**

Question 39 **(20 marks)**

Connective tissue is one of the four basic tissue types in the human body, it can be defined based on its structure by the presence of non-cellular material known as matrix. Bone and cartilage are both examples of connective tissues that provide the body with support, protection and movement.

(a) Describe the microscopic structure of compact bone and describe the structure and function of the three different types of cartilage in the human body. (12 marks)

Description	Marks
Microscopic structure of compact bone:	
Made up of units called osteons/Haversian systems	1-6
Osteons run parallel along the axis of the bone	
A central canal runs through the centre of each osteon	
The central canal can contain blood capillaries/nerves/lymph capillaries	
Layers of bony matrix called lamellae surround the central canal	
Small spaces within the lamellae are known as lacunae	
Lacunae are occupied by bone cells known as osteocytes	
Tiny canals known as canaliculi connect the lacunae/spaces in the osteons	
Types of cartilage:	
Hyaline cartilage contains closely packed/densely packed collagen fibres	1
Hyaline cartilage provides strength and flexibility/provides a smooth surface for movement at the joints	1
Fibrocartilage has a coarse appearance/has collagen fibres that are not packed as densely as hyaline cartilage/parallel bundles of collagenous fibres	1
Fibrocartilage provides support in weight-bearing locations/site of heavy pressure (such as the knee/between the vertebrae)	1
Elastic cartilage had obvious elastic fibres with not so closely packed collagen fibres	1
It provides elastic support in specific locations (such as the outer ear)	1
Total	**12**

(b) Describe the structure and range of movement of **four** different types of synovial joints.
(8 marks)

Description	Marks
Any four from the following, 1 mark for description of structure and 1 mark for description of range of movement	
Ball and socket joints have a spherical head that fits into a concave/cup-like cavity They allow for movements in all directions (except where inhibited by ligaments)	1-2
Hinge joints form when a convex surface meets a concave surface They allow for movement on one plane only/allow for flexion and extension only	1-2
Pivot joints have a pointed/rounded/conical end that connects with a ring made of bone and ligament They allow rotational movements/movement around an axis	1-2
Gliding joints are made up of irregular bones/exist between two bones that are flat (or nearly flat) at the meeting point They allow side-to-side and back-and-forth movements	1-2
Saddle joints form from two saddle-shaped bones/form from a concave and convex shape in different directions They allow side-to-side and back-and-forth movements	1-2
Condyloid/ellipsoid joints have a slightly convex bone combining with a slightly concave bone They allow for up and down and side-to-side movements	1-2
Total	**8**

Unit 2

Question 40 **(20 marks)**

Contraception methods offer the opportunity for couples to plan if and when they wish to embark on the trials and tribulations that come with parenting. Although there are many different methods of contraception, one of the most effective methods in preventing fertilisation involves the use of synthetic hormones.

(a) Name and describe the function of the hormones that normally regulate the male reproductive system and the ovarian and menstrual cycle in females. (12 marks)

Description	Marks
Follicle stimulating hormone	1
Causes production of sperm/to regulate spermatogenesis in seminiferous tubules	1
Causes the maturation of the follicle and promote oogenesis in the ovarian cycle	1
Luteinising hormone	1
Cause the production of testosterone from interstitial cells in testes	1
Causes ovulation/formation of the corpus luteum in the ovarian cycle	1
Testosterone	1
Testosterone causes maturation of the sperm/stimulates secondary male sexual characteristics	1
Oestrogen	1
Stimulates the endometrium to thicken and develop in the menstrual cycle	1
Progesterone	1
Causes the thickening and maintains the endometrium in the menstrual cycle	1
Total	**12**

(b) Explain how the combined oral contraceptive pill, and emergency hormonal contraceptives (the morning-after pill), influence the hormonal control of the ovarian and menstrual cycle to prevent fertilisation. (8 marks)

Description	Marks
The combined pill contains (synthetic) progesterone and oestrogen	1-5
It is taken throughout the ovarian & menstrual cycle/progesterone and oestrogen levels remain high throughout the whole cycle	
When the progesterone and oestrogen levels are high, the levels of FSH and LH are low/the levels of pituitary hormones/gonadotropins are suppressed	
The low FSH means follicle does not develop/the egg is not matured	
The low LH means egg/secondary ooctye cannot be released/ovulation never occurs	
Therefore the egg is never available for fertilisation (in the fallopian tube)	
The morning-after pill contains high levels of progesterone only	1
If taken within the correct timeframe/before ovulation occurs this high level of progesterone delays the release of an egg/delays ovulation	1
Because sperm can survive for up to 5-7 days this decreases the likelihood of an egg being available for fertilisation	1
Total	**8**

Question 41 **(20 marks)**

Meiosis, a process that involves DNA replication, chromosome pairing and nuclear divisions, produces unique sets of gametes for reproduction. The complex process ensures there is variation in the genotypes of offspring, which will lead to variation in phenotypes.

(a) Describe the structure of DNA and explain how this structure allows for the replication of DNA. Include in your answer a brief outline of the steps involved in DNA replication.
(10 marks)

Description	Marks
DNA structure:	
DNA is made up of two (anti-parallel) strands of nucleotides/double stranded structure	1-5
Nucleotides made up of a phosphate group, a deoxyribose sugar and a nitrogen base	
The sugar of one nucleotide bonds with the phosphate of another/there is a long chain of alternating sugar and phosphate molecules for each DNA strand/sugar-phosphate backbone	
Attached to each sugar is a nitrogen base	
4 different nitrogen bases named adenine, thymine, guanine and cytosine	
The bases for each strand are bonded together with hydrogen bonds	
Adenine only bonds with thymine	
Cytosine only bonds with guanine	
The DNA twists into a double helix shape/coiled into a spiral	
Explain why structure allows for replication of DNA + steps in DNA replication	
Hydrogen bonds between bases are relatively weak and easily broken	1-2
This means the nitrogen bases are easily exposed to allow for replication to occur	
DNA can replicate itself because of the way its double strands relate to one another/the complementary nature of the two strands	
Enzyme helicase separates the two strands of DNA	1-3
Each strand of DNA acts as a template to make new complementary strands of DNA	
DNA polymerase adds new free-floating nucleotides to form the new strands of DNA	
DNA ligase combines short sections of DNA	
This creates two new identical molecules of DNA	
Total	**10**

(b) Describe **three** processes that occur during meiosis that lead to variation. (10 marks)

Description	Marks
Crossing over:	
When homologous chromosomes pair up (during prophase I) they exchange sections of DNA	1
The chromatids for each pair cross (at the chiasma), break and exchange segments	1
This leads to a new combination of alleles in the gametes that is different from the parent cell/recombination	1
Random assortment	
When homologous pairs line up/separate they do so at random	1
The way one pair separates is unaffected by another/each pair separates independently	1
This takes place for all 23 pairs of chromosomes and leads to a new combination of chromosomes that will differ from the parent cell	1
Non-disjunction	
When a pair of chromosomes fails to separate during anaphase I or II	1-4
One daughter cell will receive an extra chromosome, one will be missing one/gametes will either have 22 or 24 chromosomes (instead of 23)	
When the gamete with the extra or missing chromosome combines with another gamete during fertilisation this can lead to	
trisomy – where there are three chromosomes when they should be a pair, or	
monosomy, where there is one chromosome when there should be a pair	
Total	**10**

End of questions

ACKNOWLEDGEMENTS

Question 14–16 Adapted from: Blueringmedia (n.d) [Anatomy of the male reproductive system diagram]. Retrieved from https://www.dreamstime.com/stock-image-anatomy-male-reproductive-system-image37867851

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