



HUMAN BIOLOGICAL SCIENCE

Stage 2

WACE Examination 2012

Marking Key

Marking keys are an explicit statement about what the examiner expects of candidates when they respond to a question. They are essential to fair assessment because their proper construction underpins reliability and validity.

When examiners design an examination, they develop provisional marking keys that can be reviewed at a marking key ratification meeting and modified as necessary in the light of candidate responses.

Section One: Multiple-choice

30% (30 Marks)

Question	Answer
1	b
2	b
3	a
4	b
5	d
6	c
7	a
8	b
9	b
10	c
11	d
12	c
13	d
14	d
15	a
16	a
17	b
18	d
19	c
20	a
21	c
22	b
23	a
24	d
25	a
26	a
27	d
28	b
29	d
30	c

a=8
b=8
c=6
d=8

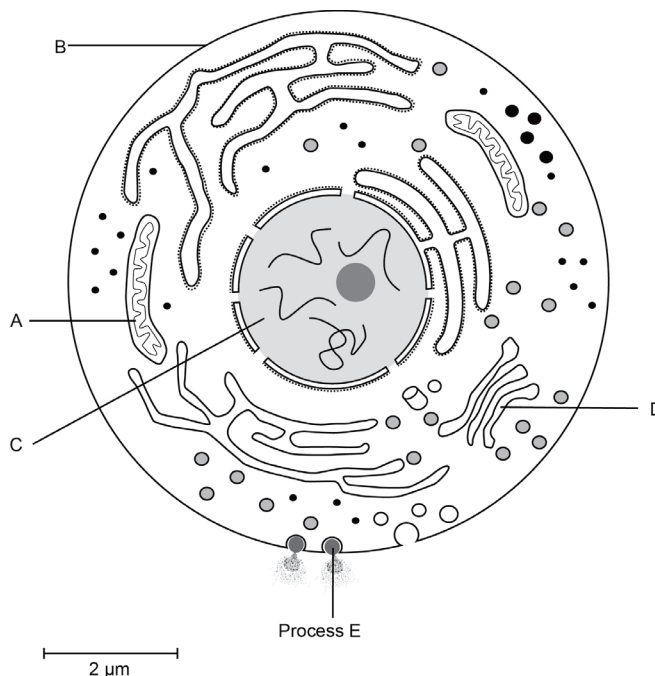
Section Two: Short answer

50% (100 Marks)

Question 31

(15 marks)

Parts (a) and (b) of this question refer to the diagram below, which shows a generalised cell.



(a) Complete the following table. (8 marks)

		Description	Marks
Organelle	Name	Function	
A	Mitochondria	<ul style="list-style-type: none"> • produces energy • site of respiration • contains mDNA 	1-2
B	Cell membrane	<ul style="list-style-type: none"> • controls entry • exit of materials • receptors • cell recognition • separates 	1-2
C	Nucleus	<ul style="list-style-type: none"> • controls cellular functions • contains DNA 	1-2
D	Golgi body	<ul style="list-style-type: none"> • package materials for export • secretion 	1-2
			Total 8

(b) Process E as labelled on the diagram shows the movement of a substance out of the cell via a vesicle. What name is given to this process? (1 mark)

Description	Marks
Exocytosis	1
	Total 1

- (c) Name and describe **two** processes other than the process identified in Part (b) that transport materials in or out of the cell. (4 marks)

Description	Marks
Any 2 of the following:	
Facilitated diffusion Movement of a substance from high to low concentration through a carrier protein molecule.	1–2
Endocytosis/ Phagocytosis/ Pinocytosis Cell engulfing a substance/ cell membrane forms around a substance and it moves into the cell	1–2
Osmosis Passive movement of water molecules in/ out of the cell.	1–2
Diffusion Movement of substances from an area of high concentration to low concentration	1–2
Active Transport Movement of substances against a concentration gradient / requiring energy.	1–2
	Total 4

- (d) Why are cells so small in size? (2 marks)

Description	Marks
Have a large surface area to volume ratio	1
Allows for efficient exchange of substances (across the membrane)/ helps maximise exchange of materials	1
	Total 2

Question 32

(12 marks)

- (a) Describe **three** healthy diet choices a pregnant woman should make to ensure the best care is given to her unborn child. (3 marks)

Description	Marks
Any 3 of the following:	
<ul style="list-style-type: none"> • Increase daily kJ intake (by 850kJ) • Avoid drug/ alcohol use/ marijuana / LSD / heroin • Increase protein intake/ eat enough red meat/ legumes • Increase folic acid consumption/ eat plenty of green leafy vegetables • Increase vitamin A consumption/ eat plenty of green and yellow vegetables • Increase calcium consumption/ eat enough dairy products • Avoid contact to listeriosis/ don't eat soft cheeses/ pate/ smoked meats/ raw meat/ pre-package salads 	1–3
	Total 3

- (b) Immunity is resistance to infection from invading micro-organisms.

Complete the table below, naming and explaining **two** ways in which a parent can increase the immunity of their infant (birth to two years old). (4 marks)

Description		Marks
Name of strategy that can increase infant immunity	How it can improve infant immunity	
Breast feeding	<ul style="list-style-type: none"> passive immunity transfer of antibodies from mother to baby 	1–2
Immunisation/ vaccination	<ul style="list-style-type: none"> active immunity injection of weakened or dead pathogens to trigger immune response 	1–2
Injection of antibodies	passive immunity	1–2
Exposure to antigens	<ul style="list-style-type: none"> active immunity builds resistance 	1–2
		Total 4

(c) The human body has many protective mechanisms that help to prevent disease-causing micro-organisms from entering the body and causing infections.

(i) What is the name given to a disease-causing micro-organism? (1 mark)

Description	Marks
Pathogen	1
	Total 1

(ii) Sneezing, coughing and vomiting are protective reflexes intended to prevent infection from occurring. How do these reflexes achieve this? (1 mark)

Description	Marks
Removes the contents (liquids or solids) which contain the pathogen	1
	Total 1

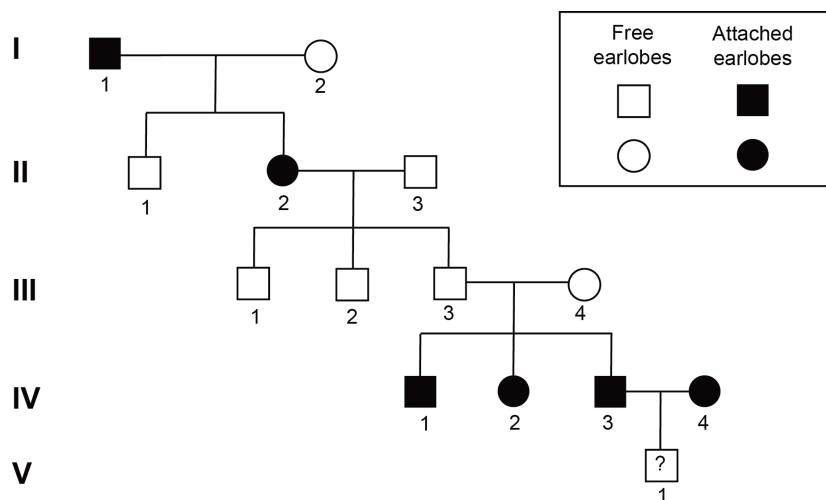
(iii) Complete the table below explain how each of the structure listed provides external protection against infection. (3 marks)

Description		Marks
Structure	How it provides external protection against infection	
Eye	<ul style="list-style-type: none"> cleansed by tears/ lysozyme tears contain chemical that inhibit bacterial growth blinking/ eye lashes 	1
Skin	<ul style="list-style-type: none"> impervious barrier sebum acts as a barrier sweat/ lysozyme 	1
Stomach	<ul style="list-style-type: none"> acidic juices kill many pathogens vomiting removes pathogens 	1
		Total 3

Question 33

(12 marks)

Parts (a), (b) and (c) of this question refer to the pedigree diagram below, which shows the inheritance of free and attached earlobes.



- (a) Given the information in the pedigree, name the type of inheritance attached earlobes display. (2 marks)

Description	Marks
Autosomal	1
Recessive	1
	Total 2

- (b) Using a punnet square, predict the genotype and phenotype of Individual V-1. (3 marks)

Description			Marks
	e	e	1
e	ee	ee	
e	ee	ee	
Genotype = 100% ee			1
Phenotype = 100% attached earlobes			1
			Total 3

- (c) Select the symbol used in the pedigree chart to indicate that the sex of an individual is male. (1 mark)

Description	Marks
Square	1
	Total 1

- (d) Name the chromosomes that determine whether an individual is a male or female. (1 mark)

Description	Marks
Sex chromosomes/ X and Y chromosomes	1
XX AND XY	Total 1

- (e) Using a punnet square, explain how the sex of a child is determined. Include in your answer an explanation of the different types of gametes and possible combinations that can occur at fertilisation. (5 marks)

Description			Marks	
Any 4 of the following:			1–4	
<ul style="list-style-type: none"> • Males produce X or Y sperm • Females produce only X ova • Either a Y or X sperm will combine with a ova • If X sperm combines with ova then a girl is produced • If Y sperm combines with ova then a boy is produced • 50/50 chance of having a boy or a girl 				
	X	Y		1
X	XX	XY		
X	XX	XY		
			Total 5	

Question 34

(11 marks)

A national football league carried out a three year trial of hair testing, which can expose the use of illicit performance enhancing drugs. The study compared the number of positive tests recorded by players offered counselling sessions with those of a group who were not given counselling. Counselling sessions were conducted once a week for one hour. Each group consisted of 100 players who were based in Melbourne who had played at the national level for one year before they began the study.

The results of the study are shown in the table below.

	Number of positive hair tests			
	Season 1	Season 2	Season 3	Average
Group A Counselling	14	10	6	
Group B No counselling	16	17	18	

- (a) Define a performance enhancing drug. (1 mark)

Description	Marks
Any substance deemed to improve physical/ athletic ability	1
	Total 1

- (b) Calculate the averages for Group A and Group B and write the answers in the table above. (2 marks)

Description	Marks
Group A= 10	1
Group B= 17	1
	Total 2

- (c) Write a suitable hypothesis for this study. (1 mark)

Description	Marks
Any statement linking the counselling to the positive test for illicit drugs E.g. Counselling sessions will reduce the likelihood of testing positive for illicit (performance enhancing) drugs.	1
	Total 1

- (d) In this study, identify the: (4 marks)

independent variable

dependent variable

two variables that were controlled in this study.

Description	Marks
Counselling sessions	1
Evidence of drug taking/ number of positive tests	1
Any 2 of the following:	1–2
• Length of time playing league (one year)	
• Same location/ all based in Melbourne	
• Same level of competition/ all playing national level	
• All underwent hair sample testing	
	Total 4

- (e) Based on the data in the table above: (3 marks)

write a suitable conclusion for this study

state how it relates to your hypothesis

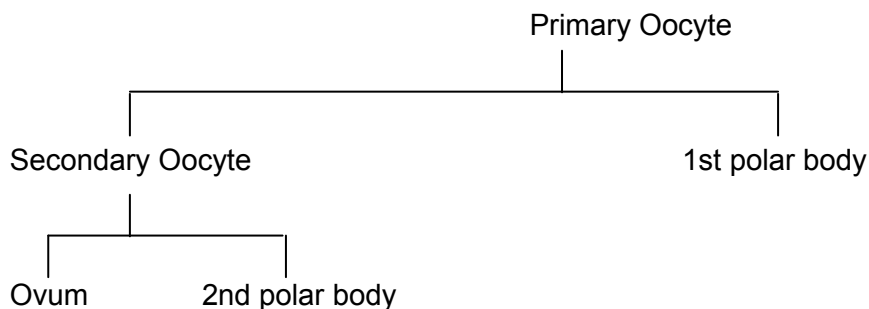
Scientific investigations are usually repeated at least once. Give a reason for this.

Description	Marks
Counselling sessions reduce the use of illicit drug taking	1
It supports/ upholds the hypothesis (cannot say proves)	1
To ensure results are reliable/ not due to chance/ reduce error	1
	Total 3

Question 35

(15 marks)

Parts (a) and (b) of this question refer to the diagram below, indicating some stages involved in the formation of human egg cells or ova.



(a) How many chromosomes would you find in: (3 marks)

Description		Marks
Primary oocyte	46	1
Secondary oocyte	23	1
Zygote (Ovum after fertilisation)	46	1
		Total 3

(b) State **two** important differences between the formation or characteristics of spermatozoa and ova. (4 marks)

Description		Marks
Any 4 of the following pairs:		
Spermatozoa	Ova	
<ul style="list-style-type: none"> • 4 sperm produced • Even distribution of cytoplasm/ little cytoplasm/ little nourishment/ short survival • Produced in testis • Small in size • Motile/ has a tail • Completes both mitotic and meiotic division at formation • Produced at puberty onwards 	1 ova produced Majority of cytoplasm/ more cytoplasm/ more nourishment/ long survival Produced in ovaries Large in size Not motile/ no tail Completes second division at fertilisation Produced before birth	1–4
		Total 4

(c) Define meiosis. (2 marks)

Description	Marks
Cell division which produces gametes/ ova and sperm	1
Resultant cells contain half usual number/ 23 chromosomes (compared to body cells)/haploid	1
Total 2	

(d) How does the process of meiosis produce genetic variation in sperm? (2 marks)

Description	Marks
Any 2 of the following:	
<ul style="list-style-type: none"> • Each sperm receives only one of each of the (homologous) pairs of chromosomes/ independent assortment • Resulting in lots of possible combinations and therefore genetic variation • Crossing over during meiosis also causes variation 	1–2
	Total 2

(e) Describe how a vasectomy works as a contraceptive. (2 marks)

Description	Marks
Vas deferens/ sperm duct has been cut / no longer one continuous tube	1
Prevents sperm from being ejaculated / released in the semen	1
	Total 2

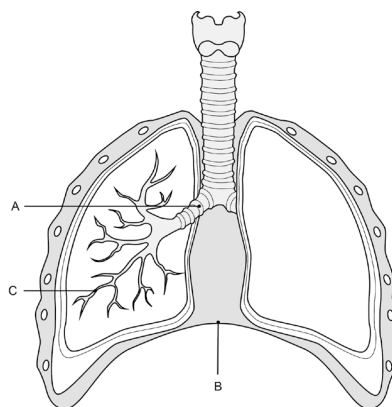
(f) Is it possible for a man who has had a vasectomy to pass on HIV to his partner? Explain your answer. (2 marks)

Description	Marks
Yes	1
Because the virus is found in the body fluids (not the sperm cells) which are still ejaculated / released	1
	Total 2

Question 36

(13 marks)

Parts (a), (b) and (c) of this question refer to the diagram below, which represents the respiratory system.



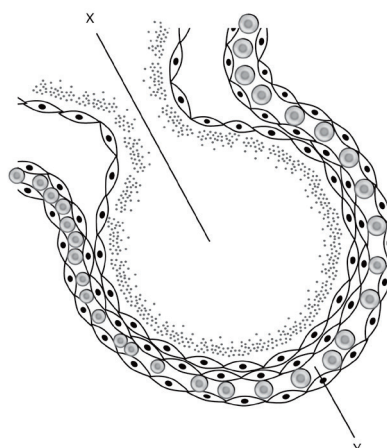
(a) Identify the structure labelled 'A' and state its function. (2 marks)

Description		Marks
Any 1 of the following		1-2
Bronchi	Pathway for air to/ from lungs	
Cartilage	Keeps airways open	1-2
		Total 2

(b) The structure labelled 'B' assists in the process of inspiration. Describe how Structure B assists the movement of air into the lungs. (4 marks)

Description	Marks
Any 4 of the following:	1-4
• Contracts	
• Moves down	
• Volume increased (in thoracic cavity)	
• Pressure decreases/ creates pressure gradient	
• Air moves from high to low	
	Total 4

The diagram below illustrates the structure that lies at the end of Structure C.



- (c) Complete the table below, identifying the name and function of the structures shown in the diagram. (4 marks)

Description			Marks
	Name of structure	Function	
X	Alveoli	Delivery of air to blood/ gas exchange	1–4
Y	Blood capillary/ vessel/ plasma	Delivery blood to alveoli/ gas exchange	
			Total 4

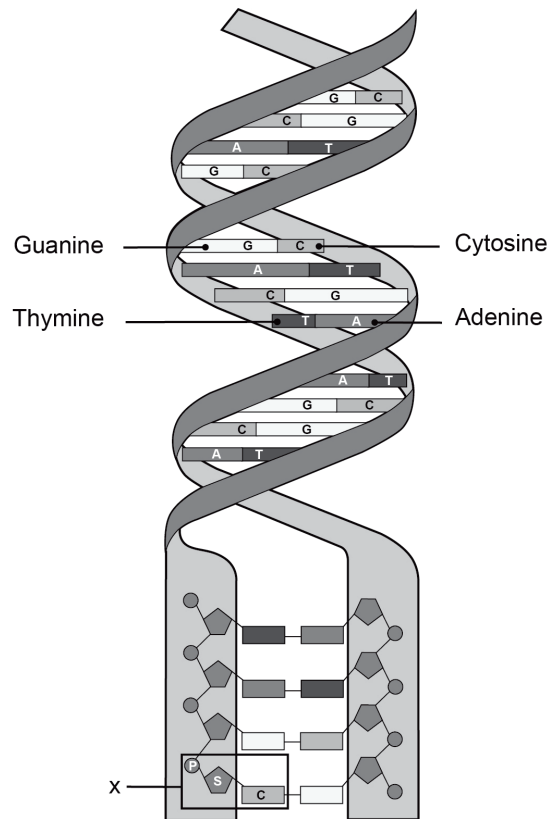
- (d) List **three** structural features that assist Structure X in achieving its function in the body. (3 marks)

Description	Marks
Any 3 of the following:	
<ul style="list-style-type: none"> • Thin • Moist • Rich blood supply • Large surface area 	1–3
	Total 3

Question 37

(12 marks)

Parts (a) and (b) of this question refer to the diagram below.



(a) Using the diagram above, complete the following table: (3 marks)

Structures labelled as Guanine, Cytosine, Adenine and Thymine are all known as:

What name is given to the region highlighted by the box marked 'X'?

Where is this type of DNA found?

Description	Marks
Bases/ nitrogen bases	1
Nucleotide	1
Nucleus	1
	Total 3

(b) The diagram shows one type of DNA. The other type is mitochondrial DNA.

- (i) Describe **one** structural difference between mitochondrial DNA and the DNA in the diagram. (1 mark)

Description	Marks
Any 1 of the following:	1
<ul style="list-style-type: none"> • Small circular molecules rather than long chains • Contains one chromosome compared to 46 • Only has 37 genes compared to 100 000s/ few compared to 100 000s • Has one heavy strand and one light strand of the helix compared to relatively even strands 	
	Total 1

- (ii) Why is mitochondrial DNA inherited only from the mother? (2 marks)

Description	Marks
Mitochondria in sperm (all in tail) are destroyed (at fertilisation)/ sperm does not contribute any mDNA	1
Leaves only the mitochondria in the ova to be passed to the embryo	1
	Total 2

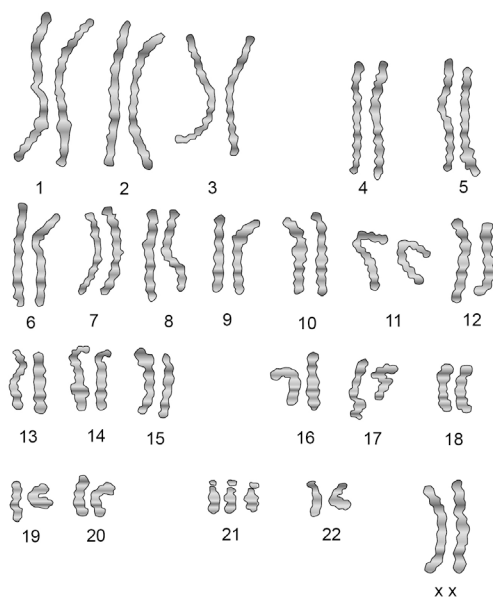
(c) Sudden changes in DNA are called often called mutations.

- (i) Name the type of mutation that occurs in reproductive cells and will be passed onto offspring. (1 mark)

Description	Marks
Germline/ germinal	1
	Total 1

- (ii) Mutagens are agents that increase the rate at which mutations occur. Name **two** specific mutagens. (2 marks)

Description	Marks
Any 2 of the following:	1-2
<ul style="list-style-type: none"> • Formaldehyde • Sulphur dioxide • Mustard gas • Some antibiotics • UV light • X-rays • Cosmic rays • Nuclear radiation • Radioactive waste 	
	Total 2



Chromosomal mutations involve all or part of a chromosome. Down syndrome is an example of a type of chromosomal mutation. The image above is a karyotype analysis of an individual with Down syndrome.

- (d) (i) Describe the way in which the DNA of an individual with Down syndrome is different from that of a normal individual. (1 mark)

Description	Marks
Extra chromosome in pair 21/trisomy of pair 21	1
	Total 1

- (ii) This type of chromosomal mutation is classed as a 'non-disjunction' or 'aneuploidy'. Explain how it can occur. (2 marks)

Description	Marks
Any 2 of the following:	1-2
<ul style="list-style-type: none"> • During meiosis • Chromosome pair does not separate • One daughter cell gets both chromosomes instead of only one 	

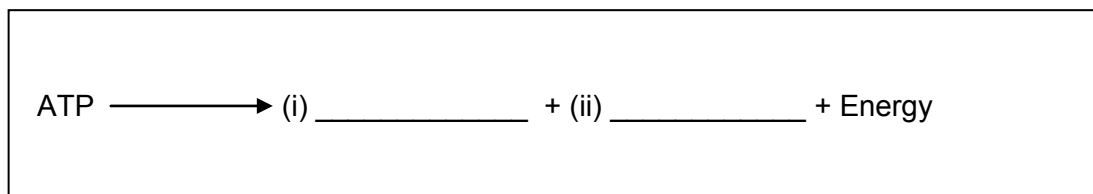
Question 38

(10 marks)

- (a) Identify the role of ATP in cell metabolism. (1 mark)

Description	Marks
Stores energy/ releases energy/ provides energy	1
	Total 1

- (b) Complete the chemical equation below, which represents the breakdown of ATP.(2 marks)



Description	Marks
(i) ADP	1
(ii) P	1
Word equation OK	Total 2

- (c) List **three** cellular uses for energy. (3 marks)

Description	Marks
Any 3 of the following:	1-3
<ul style="list-style-type: none"> • Movement • Division/ growth/ repair • Active transport • Synthesis • Exocytosis/endocytosis/ vesicular transport • Maintaining cell organisation 	
	Total 3

- (d) Using examples, describe the difference between a catabolic reaction and an anabolic reaction. (4 marks)

	Description		Marks
	Catabolic reaction	Anabolic reaction	
Description	Breakdown large molecules to smaller molecules	Synthesise large molecules from small molecules	1-2
Example	<ul style="list-style-type: none"> • Respiration • Digestion 	<ul style="list-style-type: none"> • Protein production • Hormone production 	1-2
			Total 4

Section Three: Extended answer

20% (40 Marks)

Question 39

(20 marks)

- (a) Outline the pathway taken by a red blood cell through the heart. Start at the point where blood returns to the heart via the vena cava and finish where blood leaves the heart via the aorta. Include in your answer the events that occur along the pathway. (12 marks)

Description		Marks
Pathway	Events	
RBC enters RA		1
	<ul style="list-style-type: none"> RA contracts (atrial systole) Blood forces A-V valve open/ tricuspid valve 	1
RV		1
	<ul style="list-style-type: none"> RV contracts (v. systole) Blood forces S-L valve open 	1
PA		1
	<ul style="list-style-type: none"> Artery carries RBC to lungs Gas exchange occurs Oxygen combines with Hb 	1
PV		1
	PV carries RBC back to heart	1
LA		1
	<ul style="list-style-type: none"> LA contracts (atrial systole) Blood forces A-V valve open/ bicuspid valve 	1
LV		1
	<ul style="list-style-type: none"> Contracts (atrial systole) Blood forces S-L valve open Blood (RBC) flows into aorta 	1
		Total 12

- (b) Describe **four** key structural or functional features of arteries and describe **four** key structural or functional features of veins. (8 marks)

Description	Marks	
Any 4 of the following: Arteries	1-4	
<ul style="list-style-type: none"> Carry blood away from the heart Changing blood pressure/ blood pressure increases when heart contract/ blood pressure decreases when heart relaxes Thick walls Elastic walls/ muscular walls No valves Can vasoconstrict/ vasodilate Smaller lumen 		
Any 4 of the following: Veins	1-4	
<ul style="list-style-type: none"> Carry blood towards the heart Have a constant blood pressure/ relative low blood pressure Thin walls Inelastic walls/ little muscle Valves Remain the same diameter Larger lumen 		
		Total 8

Question 40

(20 marks)

- (a) Outline the pathway of a sperm from its formation in the testis to its release in semen from the body. Include in your answer the major events that occur along the pathway. (8 marks)

Description	Marks
Any 8 of the following:	
<ul style="list-style-type: none"> • Cells which produce sperm line the seminiferous tubules • Sperm are then stored/ mature in the epididymis • Carried (away from the testis) in the vas deferens/ sperm duct • Secretions are added to the sperm to form semen/ seminal fluid • Pass the seminal vesicles • Which add fluid/ sugary liquid • Pass the prostate gland • Which secretes (milky/alkaline) fluid • Pass the bulbourethral / Cowpers glands • Which secrete mucus/ lubricant/ fluid • Semen/ sperm and secretions then travel through the urethra • This tube carries the semen along the shaft of the penis 	1–8
	Total 8

- (b) Infertility refers to the biological inability of a person to contribute to conception.

- (i) List **five** causes of infertility. (5 marks)

Description	Marks
Any 5 of the following:	
<ul style="list-style-type: none"> • Endometriosis/ tissue lining uterus grows on other tissues • Low sperm count in male/ high temperature of testis • Poor sperm mobility • Blocked oviduct • Blocked sperm duct • Cervical mucus prevents sperm entry • Physical defect in egg/sperm • Tumours/growths in testes/ovaries • Hormonal imbalance • Old age/menopause • Excessive exercise • Extremes of weight range • Sexually transmitted infections • Low ova count/ Poor ovarian reserve • PCOS 	1–5
	Total 5

- (ii) Some types of infertility can be overcome with in-vitro fertilisation (IVF). Explain the procedure used in IVF. (7 marks)

Description	Marks
Any 7 of the following:	
<ul style="list-style-type: none"> Fertility drugs increase the number of ova/sperm produced Sperm are collected from the male Ova are collected from the female Ova must be collected at ovulation Sperm are added to ova in a glass dish/ test tube Nutrient medium is provided Kept at body temperature Fertilisation occurs in the dish/ embryos formed in dish Resultant embryos implanted into woman's uterus 	1-7
	Total 7

Question 41

(20 marks)

- (a) Describe **three** key features of embryonic stem cells and describe **three** key features of adult stem cells. (6 marks)

Description	Marks
Any 3 of the following:	
Embryonic <ul style="list-style-type: none"> Occur in 3-5 day old embryo Cultured from frozen embryos Can become any cell type/ pluripotent Ethical issues involved/ government regulations/ embryo destroyed to obtain them Rejection possible as not patients own cells 	1-3
Any 3 of the following:	
Adult <ul style="list-style-type: none"> Occur in adult tissues such as bone marrow/ brain Also obtained from cord blood/ umbilical cord/ placental blood Can form many cell types/ multipotent Fewer risks/ ethical issues in obtaining them 	1-3
	Total 6

- (b) Pregnant women are advised not to consume alcohol, as it is a teratogen.

- (i) List **four** negative effects alcohol can have on a foetus. (4 marks)

Description	Marks
Any 4 of the following:	
<ul style="list-style-type: none"> Foetal Alcohol Syndrome Lower than normal birth weight Slow growth rate Small head Face irregularities/narrow eye slits Heart defects Malformed limbs Mental retardation Behavioural problems/ hyperactivity/ poor attention span 	1-4
	Total 4

- (ii) Name and describe the effects of **two** other types of teratogens. (4 marks)

Description		Marks
Any 2 of the following:		
Name	Describe	
Cigarette smoke/passive smoke	Lower birth weight/ increased risk of miscarriage/ respiratory problems/ SIDS	1–2
Thalidomide/ methyl mercury	Malformed limbs/ convulsions/ brain damage	1–2
LSD/ marijuana/ heroin	Intellectual disabilities/ gastro-intestinal problems	1–2
Antibiotics/ anticoagulants/ anticonvulsants/ antitumor drugs	Drugs may be toxic/ impair normal development	1–2
Rubella/ German measles hepatitis/ mumps/ influenza/ toxoplasmosis/ listeria	Blindness/ deafness/ heart malformations/ brain damage/ miscarriage	1–2
Ionising radiation / x-rays / radioactive waste	Neurological / skeletal malformations and germ line mutations	1–2
		Total 4

- (c) Outline the patterns and milestones of development in a normal infant from birth to age two years under the following headings: (6 marks)

- (i) physical development
(ii) motor development
(iii) social development.

Description	Marks	
Any 2 of the following:		
Physical <ul style="list-style-type: none"> • Rapid growth (particularly in first year) • Increase in height • Increase in weight • Decrease in head size to compared to body (change in head to body ratio) 	1–2	
Any 2 of the following:		
Motor <ul style="list-style-type: none"> • Head to foot/ cephalocaudal / coordination of movements goes from head to hands to feet • Proximodistal /development outwards / controlled movement of upper arm to hand to fingers • Gross to specific / development of larger muscle movements to finer / excessive movement to precise muscle control 	1–2	
Any 2 of the following:		
Social <ul style="list-style-type: none"> • Differentiate between people/ recognise people/ identify mother • Smiling at faces/ people • Uses sounds to communicate/ early words/ talking 	1–2	
		Total 6

Question 42

(20 marks)

(a) Describe the chemical composition of the major organic nutrients:

(6 marks)

- (i) carbohydrates
- (ii) proteins
- (iii) lipids.

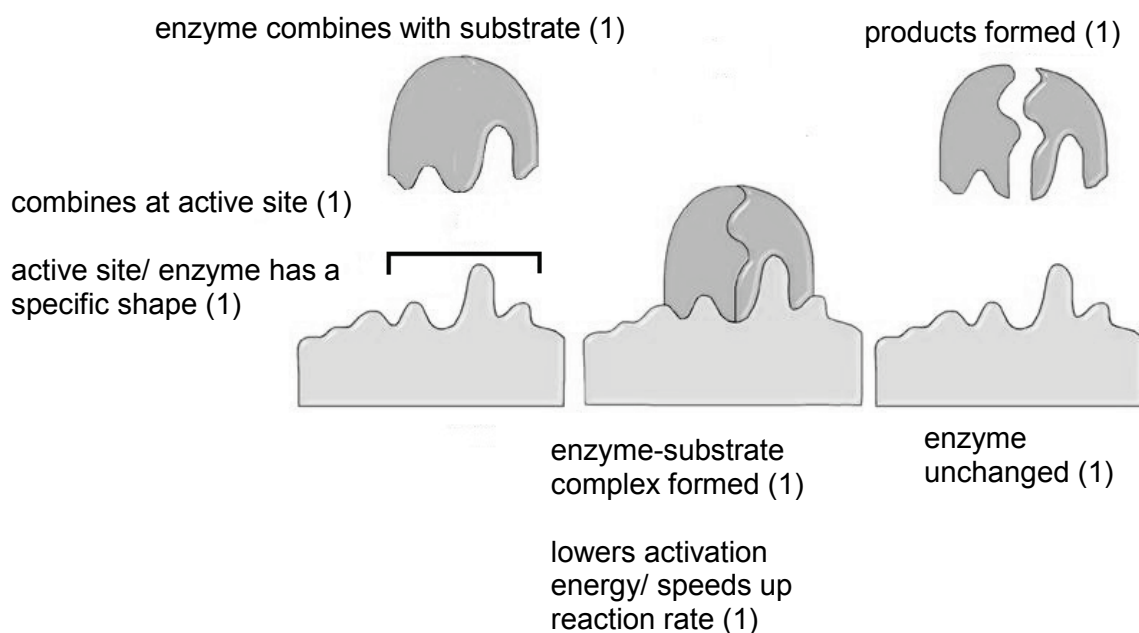
Description	Marks
Any 2 of the following:	
Carbohydrates <ul style="list-style-type: none"> • Contain carbon, hydrogen and oxygen • Composed of simples sugars / mono/ disaccharides 	1–2
Any 2 of the following:	
Protein <ul style="list-style-type: none"> • Contain carbon, hydrogen and oxygen • nitrogen/sulphur/phosphorus <p>1. Composed of amino acids/ polypeptides/ peptides</p>	1–2
Any 2 of the following:	
Lipids <ul style="list-style-type: none"> • Contain carbon, hydrogen and oxygen • Composed of fatty acids • and glycerol 	1–2
	Total 6

(b) Enzymes play an important role in the breakdown of food so that absorption can occur.

Using the 'Lock and Key' model, describe the action of enzymes and list **two** factors that can affect their action. (7 marks)

Description	Marks
Any 5 of the following: <ul style="list-style-type: none"> • Enzyme combines with substrate • Combines at the active site • Active site/ enzyme has a specific shape • Enzyme-substrate complex formed • Lowers the activation energy/ speeds up the reaction • Products formed (can either be catabolic or anabolic) • Enzyme unchanged Labelled diagram accepted	1-5
Any 2 of the following factors: Affected by <ul style="list-style-type: none"> • pH • Temperature • Co-factors • Co-enzymes • Concentration of enzymes 	1-2
	Total 7

Any 5 of the following:



- (c) Describe the mechanical and chemical digestion of lipids in the body. Include an explanation of how the body absorbs them. (7 marks)

Description	Marks
Any 5 of the following:	
<ul style="list-style-type: none"> • Mechanical digestion occurs in mouth/duodenum • Action of teeth/ tongue/ cheek • Bile action • Lipids are emulsified • Chemical digestion occurs in duodenum/intestine • Action of pancreatic lipase • Action of intestinal lipase 	1–5
Absorption occurs in small intestine/ villi	1
Into the lacteals/ lymphatic system	1
	Total 7

ACKNOWLEDGEMENTS

Section Two

- Question 31** Adapted from: *Cell structure* [Diagram]. Retrieved January, 2012, from http://cronodon.com/BioTech/Cell_structure.html.
- Question 33** Adapted from: *Pedigree chart 2*. Retrieved January, 2012, from <http://lsnhs.leesummit.k12.mo.us/cgerding/PreIBBiology/Genetics/chapter12practicetest.htm>.
- Question 36** Diagram of the respiratory system by courtesy of the examining panel.
- Question 36(c)** Diagram of a respiratory system component by courtesy of the examining panel.
- Questions 37(a) and (b)** Adapted from: The structure of DNA [Diagram]. National Institute of General Medical Sciences. (2010). *The new genetics*, p. 7. Retrieved January, 2012, from <http://publications.nigms.nih.gov/thenewgenetics/chapter1.html>.
- Question 37(d)** Adapted from: *Karyotype analysis of an individual with Down syndrome* [Diagram]. Retrieved January, 2012, from www.ucl.ac.uk/~ucbhjow/bmsi/bmsi_7.html.