



**SYDNEY TECHNICAL HIGH
SCHOOL**

2013

**TRIAL HIGHER SCHOOL
CERTIFICATE
EXAMINATION**

Biology

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your name in the space provided

Student Number

Student Name

Total marks – 100

Section I

85 marks

This section has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1-20
- Allow about 35 minutes for this part

Part B – 65 marks

- Attempt Questions 21-32
- Allow about 1 hour and 55 minutes for this part

Section II

15 marks

- Attempt all parts of question 33
- Allow about 30 minutes for this section

Section I

85 marks

Part A – 20 marks

Attempt Questions 1-20

Allow about 35 minutes for this part

Use the multiple-choice answer sheet.

Select the alternative A,B,C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

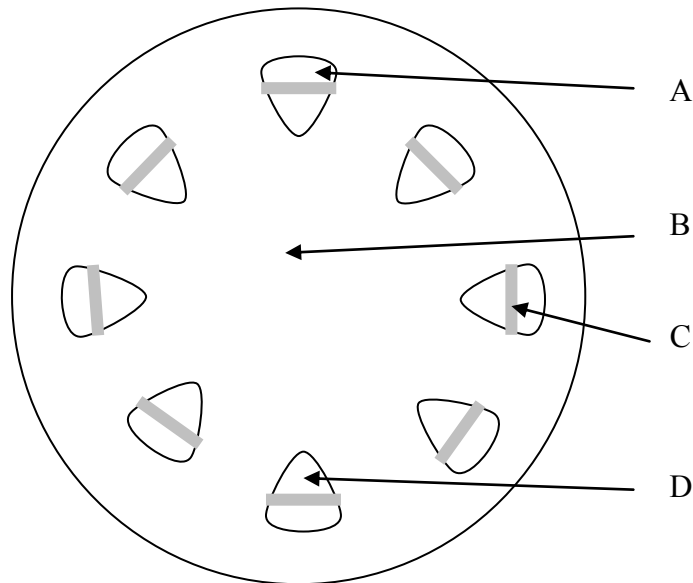
A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A B C D
correct

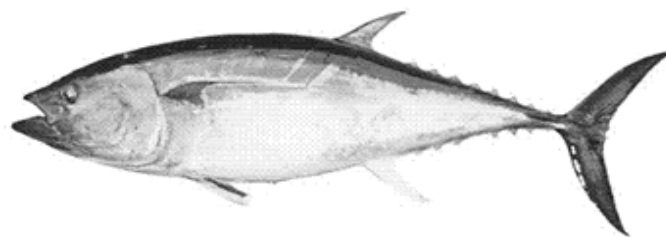
Student Number

1. The diagram below is of a transverse section through a plant stem.



Through which tissue are dissolved mineral ions transported?

- (A) A
 - (B) B
 - (C) C
 - (D) D
2. The Southern Bluefin Tuna lives in the open ocean.



www.fish.gov.nz

Which one of the following best describes its water balance problem.

- (A) It loses too much water due to osmosis.
- (B) It loses too much salt due to active transport.
- (C) It gains too much water due to osmosis.
- (D) It gains too much salt due to active transport.

3. Humans and whales differ in their ability to excrete salt in their urine. The table below shows the volume of urine that each would need to produce to excrete the salt in a litre of sea water (35g)

	Volume of urine needed to excrete 35g of NaCl. (mL)
Human	1350
Whale	650

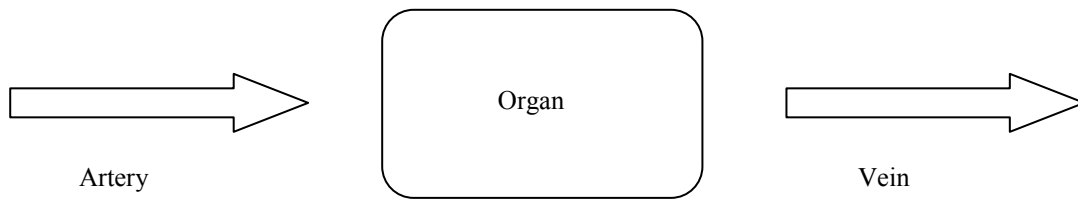
Which one of the following statements is true?

- (A) Whale urine is more concentrated than human urine.
 - (B) Whales store salt, rather than excrete it.
 - (C) Whale urine is more dilute than human urine.
 - (D) Whales produce low volumes of urine.
4. Transport of materials through plants occurs in the xylem and phloem.

Which one of the following is an example of active transport?

- (A) Absorption of water from the soil into the xylem of the root.
 - (B) Loading of sugars from photosynthetic cells into the phloem.
 - (C) Unloading of water from the xylem into photosynthetic cells.
 - (D) Movement of sugars between sieve elements in the phloem.
5. A rise in blood solute concentration, detected by the hypothalamus, would trigger:
- (A) increased aldosterone output
 - (B) decreased aldosterone output
 - (C) increased ADH output
 - (D) decreased ADH output

6. Samples of blood were taken from the artery flowing into an organ, and from the vein flowing from it.



Relative levels of some dissolved substances found in the blood samples are given in the table below.

	Artery	Vein
Bicarbonate ions	<i>low</i>	<i>high</i>
Glucose	<i>low</i>	<i>high</i>

Identify the organ.

- (A) lungs
 - (B) small intestine
 - (C) kidney
 - (D) brain
7. Base analysis of a sample of DNA has determined that 15% of the sample is made up of the base Guanine. Thus the correct estimate of one of the remaining bases would be
- (A) 15% Adenine
 - (B) 35% Cytosine
 - (C) 15% Alanine
 - (D) 35% Thymine

8. Many useful products are obtained from donated blood.

Choose the line which correctly matches the products with their uses.

	Plasma	Red blood cells	Platelets
(A)	To increase the clotting ability of the blood	To increase the immune response against pathogens.	To restore blood volume after injury.
(B)	To boost oxygen carrying capacity of the blood.	To restore blood volume after injury.	To increase the immune response against pathogens.
(C)	To restore blood volume after injury.	To boost oxygen carrying capacity of the blood.	To increase the clotting ability of the blood
(D)	To increase the immune response against pathogens.	To increase the clotting ability of the blood	To boost oxygen carrying capacity of the blood.

9. In his book 'Darwin's Island', Steve Jones points out that 20% of the men of North West Ireland have identical Y chromosomes. This is evidence that they are all descended from the same male ancestor, and Jones names a fifth century warlord, 'Niall the Hostage Taker' as that ancestor.

Of all the human chromosomes, only the Y chromosome can be passed on unchanged from generation to generation.

Why?

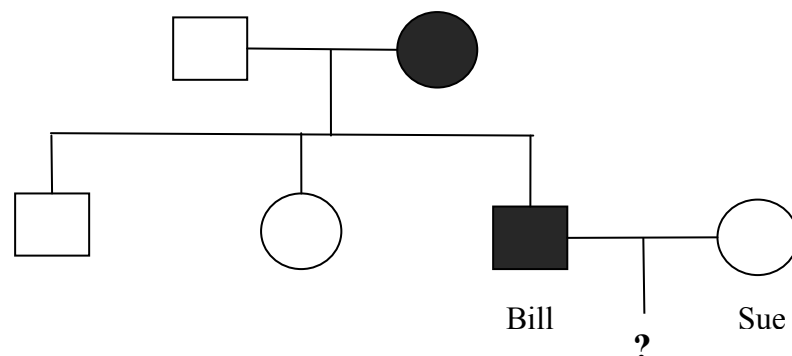
- (A) The Y chromosome does not undergo mutation.
- (B) The Y chromosome does not undergo meiosis.
- (C) The Y chromosome does not undergo crossing over.
- (D) The Y chromosome does not segregate randomly.

10. Which one of the following is a factor which influenced Darwin in delaying the publication of his theory?
- (A) The great majority of society accepted the biblical version of creation, so his theory would provoke great controversy.
 - (B) He was not well known in scientific circles, so other scientists would be unlikely to accept his ideas.
 - (C) Alfred Russel Wallace had proposed a different theory, which was supported by influential scientists, so he wanted to be sure of his evidence.
 - (D) Sea travel was very slow. It took him many years to return home from the Galapagos Islands.

11. Who was/were responsible for establishing that the hereditary material is carried on chromosomes?
- (A) Watson and Crick
 - (B) Morgan
 - (C) Beadle and Tatum
 - (D) Sutton and Boveri

12. The pedigree below shows the inheritance of polycystic kidney disease in a family.

The affected gene is carried on chromosome no. 16, and the allele which causes the condition is dominant.



One of Sue's parents also has the condition.

What is the probability of Bill and Sue's unborn child showing the condition?

- (A) 100%
- (B) 75%
- (C) 50%
- (D) 25%

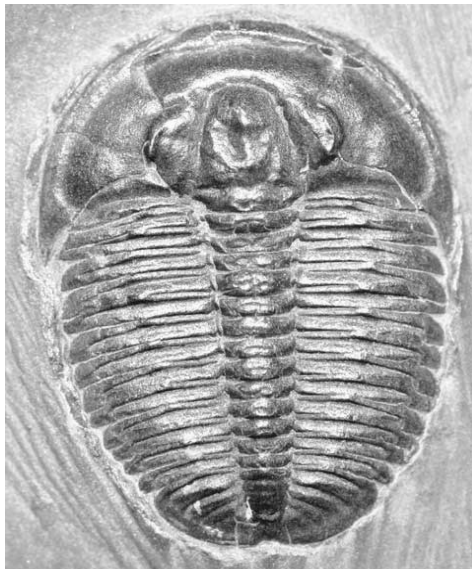
13. In pea plants, the allele for green pods (G) is dominant over that for yellow pods (g).

A plant breeder crosses two pea plants and obtains the following offspring:

424 plants with green pods : 399 plants with yellow pods

What are the most likely genotypes of the parent plants?

- (A) GG x gg
 - (B) Gg x gg
 - (C) Gg x Gg
 - (D) gg x gg
14. The photograph below is of a fossil trilobite, an extinct invertebrate.



The fossil record of trilobites shows that species remain essentially the same for millions of years until they are ‘suddenly’ replaced by new species.

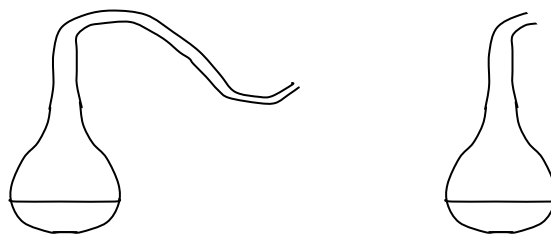
There is a lack of trilobite fossils which show transition between the different species.

Which one of the following mechanisms are these observations most consistent with?

- (A) Punctuated equilibrium
- (B) Adaptive radiation
- (C) Convergent evolution
- (D) Divergent evolution

15. Identify the **incorrect** statement about the lymphatic system.
- (A) Includes lymph nodes, lymphatic vessels, the spleen, thymus and tonsils.
 - (B) Contains lymphocytes, macrophages and red blood cells.
 - (C) Collects fluid from the extracellular spaces and returns it to the blood.
 - (D) Absorbs lipids from the digestive system.
16. Which one of the following defence adaptations relies upon the release of histamine to stimulate blood flow to the area and encourage flow of fluid from the capillaries into the tissues?
- (A) inflammation
 - (B) phagocytosis
 - (C) lymph node swelling
 - (D) auto-immunity
17. Louis Pasteur performed a famous experiment in which he sterilised the nutrient broth in two swan necked flasks.

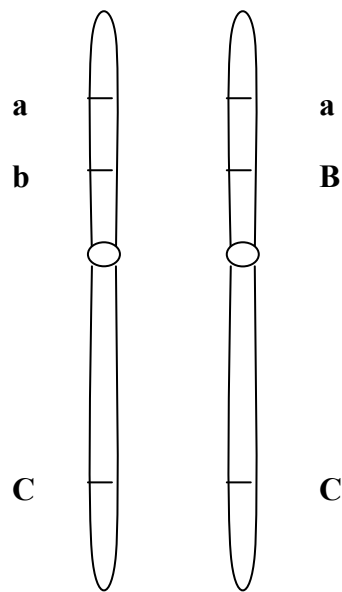
He then broke the neck off one of them and found that the broth in the broken flask became infected with microbes, but the broth in the other flask remained clear and uninfected.



The main conclusion that Pasteur drew from this experiment was that:

- (A) microbes arise by spontaneous generation.
- (B) all disease and decay is caused by microbes.
- (C) microbes can be destroyed by heating
- (D) microbes causing decay are carried in the air.

18. The diagram below shows a homologous pair of chromosomes. The alleles of three genes are indicated.



Which one of the following statements is true?

- (A) This person's gametes will all carry the B allele.
- (B) All of this person's offspring will inherit the a allele.
- (C) If this person marries someone with the same genotype, then their children will also have this genotype.
- (D) These two chromosomes can be said to be homozygous.

19. When Legionnaire's disease was first encountered in the United States the health authorities immediately set about finding the causative pathogen.

They examined the lungs of people who had died from the disease, and they discovered a rod-like bacterium in all of them. This bacterium was not present in the lungs of healthy people.

They isolated this bacterium and grew it in pure culture.

What other step would they need to take before they could be justified in naming this bacterium as the causative pathogen?

- (A) They need to produce a vaccine against it and demonstrate that it protects people from the disease.
- (B) They need to see whether an antibiotic which cures people of the disease, also kills the cultured bacteria.
- (C) They need to sequence the DNA of the bacteria from people who have the disease and of the cultured bacteria, and see whether they are the same.
- (D) They need to infect a susceptible organism with bacteria from the culture, and see whether it develops both an infection of the bacteria and the symptoms of the disease.

20. *Candidiasis*, or thrush, is a fungal infection which can occur in the female reproductive tract and in the intestine.

One of the factors which can trigger it is taking large amounts of antibiotics.

This is because:

- (A) the *Candida* pathogen actually feeds on antibiotics.
- (B) overuse of antibiotics weakens the body's immune system, making it susceptible to opportunistic infections like *Candida*.
- (C) antibiotics kill the natural bacterial flora which normally outcompete *Candida*, allowing it to become a major infection.
- (D) Antibiotic resistant strains of *Candida* evolve very quickly.

Section I (continued)

Part B –65 marks

Attempt Questions 21 - 32

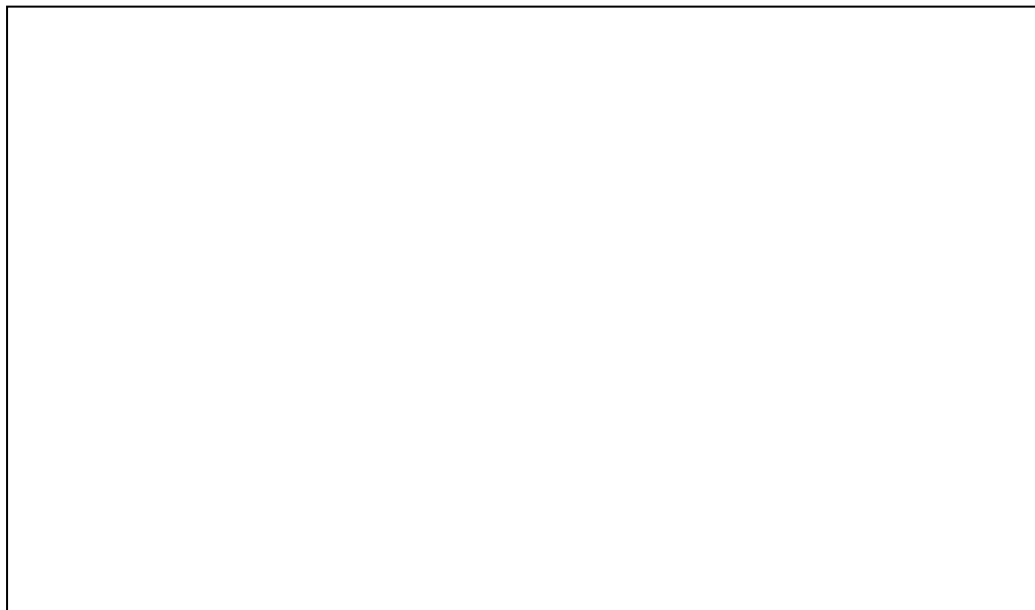
Allow about 1 hour and 55 minutes for this part

Answer the questions in the spaces provided.

	Marks
Question 21 (5 marks)	

(a) Draw a diagram below to illustrate a model for enzyme function. **3**

Label the model to show how it accounts for enzyme specificity and the ability of the enzyme to catalyse subsequent reactions.



(b) Explain how the chemical composition of enzymes makes them highly specific. **2**

.....

.....

.....

.....

.....

.....

Question 22 (4 marks)

Marks

(a) Describe homeostasis.

1

.....
.....
.....

(b) Explain the role of the nervous system in maintaining homeostasis.

3

.....
.....
.....
.....
.....
.....
.....
.....
.....

5

Question 23 (5marks)

Complete the table below to compare and explain the responses of ectothermic and endothermic organisms to temperature change.

	Response to change in ambient temperature	How response assists temperature regulation
Australian ectotherm eg:		
Australian endotherm eg:		

Question 24 (5 marks)

Marks

(a) Relate the structure of capillaries to their function.

2

.....
.....
.....
.....
.....

(b) Explain the adaptive advantage of haemoglobin in red blood cells.

3

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

Question 25 (6 marks)

Draw a diagram of the kidney in the space below. Label 3 regions and describe the main process that occurs in each.

6

Question 26 (3 marks)

Marks

Justify how the study of vertebrate forelimbs supports the theory of evolution.

3

.....
.....
.....
.....
.....
.....
.....
.....
.....

Question 27 (5 marks)

The tortoiseshell cat has a combination of black and orange fur. The gene for black fur is represented by X^b and the gene for orange fur is represented by X^o . A tortoiseshell female cat (X^bX^o) mates with a black male cat (X^bY).

(a) Determine the probable percentages of coat colour in the phenotype for the litter of kittens. Show all working.

2

.....
.....
.....
.....
.....

(b) Explain the tortoiseshell phenotype.

2

.....
.....
.....

(c) Explain why tortoiseshell cats are never male.

1

.....
.....

Question 28 (8 marks)

Marks

- (a) Construct a flow chart in the space below to outline the process by which DNA controls the production of polypeptides.

5

- (b) Analyse how gene expression is involved in the maintenance and repair of body tissues.

3

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Question 30 (8 marks)

Marks

A team of US scientists have used a human skin cell to create a cloned human embryo from which they were able to extract embryonic stem cells, a world first. These stem cells are genetically matched to the person who donated the skin cell and can form any cell type for possible organ repair and transplant. The technique used to create the cloned embryonic cells is known as somatic cell nuclear transfer. These cloned embryonic cells are not placed in a surrogate uterus to develop into a foetus but can be used to generate stem cells for patients with dysfunctional or damaged tissues and organs.

The discovery is published in the prestigious journal *Cell*. Until now, researchers have only been able to grow embryonic stem cells from surplus IVF embryos which are not a genetic match with the recipient patient.

- (a) You have studied the commonly used cloning technique of nuclear transfer (used to produce Dolly the sheep). Outline 3 basic steps researchers would have used to produce embryonic stem cells from the human skin cell.

3

.....
.....
.....
.....
.....
.....
.....
.....

- (b) Identify one ethical issue associated with this research.

1

.....
.....

Question 30 (8 marks) continued

Marks

- (c) Explain the advantage of using these embryonic stem cells for tissue or organ transplant compared to the use of stem cells derived from IVF embryos.

4

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Question 31 (4 marks)

4

Construct a table in the space below to show one feature which distinguishes between prions and viruses and name a disease caused by each pathogen.

Section II

15 marks

Attempt all parts of Questions 33

Allow about 30 minutes for this section

Question 33 --- Communication (15 marks) **Marks**

- (a) Students have observed that the pupil of the eye constricts (becomes smaller) when the eye is exposed to strong light. Explain how this response occurs. **4**
- (b) Compare the range of wavelengths of the electromagnetic spectrum detected by humans with those of one other animal and suggest reasons for the differences. **3**
- (c) Describe cataracts and the technology used to prevent blindness from cataracts. **3**
- (d) Explain the importance of accommodation for visual communication and describe how it is achieved within the eye. **5**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Section I A Multiple Choice

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
D	A	D	B	C	B	D	C	C	A	D	C	B	A	B	A	D	B	D	C

Section I B**21 (a)**

Marking Guidelines	Marks
<ul style="list-style-type: none"> Diagram of enzyme catalysed reaction with enzyme and substrate labelled. Specific fit of active site with substrate noted. Enzyme unchanged and available to catalyse further reactions noted. 	3
<ul style="list-style-type: none"> 1-2 of the above 	1-2

**21 (b)**

Marking Criteria	Marks
<ul style="list-style-type: none"> Describes the chemical composition of enzymes Links structure to shape of active site and thus specificity 	2
<ul style="list-style-type: none"> One of above 	1

Enzymes are proteins made up of one or more polypeptide chains containing a particular sequence of amino acids. The amino acid sequence defines the 3-d shape of the protein and produces a unique shape of the active site which allows specific binding to a particular substrate.

22 (a)

Marking Criteria	Marks
<ul style="list-style-type: none"> Correctly describes homeostasis 	1

Homeostasis is the process by which organisms maintain a relatively stable internal environment.

22 (b)

Marking Criteria	Marks
<ul style="list-style-type: none"> Explains that receptors detect any change from the stable state Explains that the brain can initiate responses to counteract the change and return the internal environment to its stable state Explain that nerve impulses along sensory nerves and motor nerves link receptors to the CNS to effector organs 	3
<ul style="list-style-type: none"> Two of the above 	2
<ul style="list-style-type: none"> One of the above 	1

Homeostasis involves the detection of any change from the stable state followed by responses which counteract the change to return the internal environment to its stable state. The nervous system detects changes using specialized receptor cells. These generate nerve impulses which travel along sensory nerves to the spinal cord and brain (CNS). The brain initiates an appropriate response through stimulating effector muscles and glands via nerve impulses sent along motor nerves.

23

Marking Criteria	Marks
<ul style="list-style-type: none"> Correctly names one Australian ectotherm and one Australian endotherm Identifies a response to temperature change in the ectotherm Explains how it assists temperature regulation Identifies a response to temperature change in the endotherm Explains how it assists temperature regulation 	5
<ul style="list-style-type: none"> 3 -4 of the above 	3-4
<ul style="list-style-type: none"> 1 -2 of the above 	1-2

	Response to change in ambient temperature	How response assists temperature regulation
Australian ectotherm eg: ...Goanna.....	At low temperatures they will flatten body while basking in the sun	This increases the surface area exposed to the heat of the sun and so more heat is absorbed to quickly raise their body temperature
Australian endotherm eg: ..Kangaroo.....	At high temperatures they dilate blood vessels in their front paws and lick the paw surface	This increases blood flow to these extremities to allow for heat loss from the body by radiation. The evaporation of saliva increases heat loss.

24(a)

Marking Criteria	Marks
<ul style="list-style-type: none"> • Describes structure • Relates structure to function 	2
<ul style="list-style-type: none"> • 1 of above 	1

Capillaries are microscopic blood vessels with walls only one cell thick. They directly supply all body tissues with blood. Their structure allows rapid and efficient gas exchange and diffusion of nutrient and waste molecules between the blood and body cells.

24 (b)

Marking Criteria	Marks
<ul style="list-style-type: none"> • Describes the function of haemoglobin • Links increased carrying capacity for oxygen with structure • Explains advantage of loading and unloading oxygen in the body. 	3
<ul style="list-style-type: none"> • 1-2 of the above 	1-2

The major role of haemoglobin (Hb) is the transport of oxygen from lungs to body cells for respiration. Hb is a protein with 4 iron containing haem groups. These allow Hb to bind 4 molecules of oxygen. Since oxygen has a low plasma solubility, Hb provides a much higher oxygen carrying capacity (~100x).



Haemoglobin can combine with oxygen loosely and reversibly. It has the ability to bind oxygen maximally in the lungs (at high oxygen concentrations) and is able to release this oxygen readily and completely in tissue capillaries (low oxygen). Thus Hb efficiently loads oxygen in the lungs and unloads it to respiring tissues to satisfy the metabolic needs of cells.

25

Marking Criteria	Marks
<ul style="list-style-type: none"> • Draws a diagram of the kidney • Correctly labels the cortex and describes the process of filtration • Correctly labels the medulla and describes the process of reabsorption • Correctly labels the pelvis OR the ureter and describes their function 	6
<ul style="list-style-type: none"> • 1-3 of the above 	1-5

26

Marking Criteria	Marks
<ul style="list-style-type: none">• Describes the homologous structures• Gives a number of vertebrate examples• Explains how they support the theory of evolution	3
<ul style="list-style-type: none">• 1-2 of the above	1-2

The comparison of vertebrate forelimbs, eg. whale flipper, bird wing, bat wing, lizard forelimb, human hand and forearm, all show a similar bone anatomy of the pentadactyl (five-fingered) limb and the ulna, humerus and radius. These homologous (similar) structures support the theory of divergent evolution: that vertebrates evolved from a common ancestor and have diverged by a process of adaptive radiation to produce species with different forelimb characteristics and functions.

27 (a)

Marking Criteria	Marks
<ul style="list-style-type: none">• Shows working correctly eg Punnett Square• Records probable percentages of coat colour expected	2
<ul style="list-style-type: none">• 1 of above	1

25% Black female
25% Black male
25% Tortoiseshell female
25% Orange male

27 (b)

Marking Criteria	Marks
<ul style="list-style-type: none">Identifies the alleles are co-dominantExplains the phenotype	2
<ul style="list-style-type: none">Incomplete answer	1

The alleles for orange fur and for black fur are co-dominant. Thus the heterozygous genotype produces the tortoiseshell phenotype, where both alleles are expressed.

27 (c)

Marking Criteria	Marks
<ul style="list-style-type: none">Correct explanation	1

Since the gene for coat colour is on the X chromosome and not on the Y, only females with two X chromosomes can be heterozygous for coat colour and thus tortoiseshell.

28 (a)

Marking Criteria	Marks
<ul style="list-style-type: none">Transcription and translation identified in the flow chartSynthesis of mRNA in nucleus outlined.Attachment of mRNA to ribosome describedTranslation identified and described including role of tRNA and ribosomeRole of amino acids described	5
<ul style="list-style-type: none">1-4 of above	1-4

Section of DNA molecule in the nucleus “unzips”.



Transcription

A complementary mRNA strand is produced from nucleotides in the nucleus using the DNA segment as a template.



mRNA moves into the cytoplasm and attaches to a ribosome which moves along and activates successive codons on the mRNA strand.



Translation

tRNA with its specific amino acid binds its anti-codon to the complementary codon along mRNA as the ribosome move along the mRNA strand.



The polypeptide is formed as each successive amino acid specified by the mRNA sequence binds together with peptide bonds and tRNA is released.

28 (b)

Marking Criteria	Marks
<ul style="list-style-type: none"> • Identifies that correct gene expression results in the production of functional proteins. • Describes the role of proteins in maintenance of body tissues using examples • Describes the role of gene expression in mitosis and differentiation needed for repair of body tissues 	3
<ul style="list-style-type: none"> • 1-2 points 	1-2

Correct gene expression results in the production of all the required proteins needed for maintenance and repair of body tissues. Enzymes control all metabolic processes; protein hormones eg. insulin are needed for homeostasis; proteins form ion channels and receptors on cell membranes; antibodies for defense are immunoglobulin proteins; haemoglobin transports O₂; rhodopsin pigment in photoreceptors is a protein; collagen, actin, myosin are all structural proteins in body tissues.

Mitosis and cell differentiation needed for repair of tissues is regulated by protein Growth Factors which are produced as a result of gene expression. Faulty genetic control of mitosis can lead to uncontrolled cell division and cancer. Normal differentiation of cells for specialized tissue functions occurs because only some genes of the total genome are expressed eg. The gene for haemoglobin is only expressed by red blood cells. Cancer cells are often undifferentiated.

29(a)

Marking Criteria	Marks
<ul style="list-style-type: none"> • Axes correctly labeled • Accurate plot • Column graph or histogram 	3
<ul style="list-style-type: none"> • 1-2 of the above 	1-2

29(b)

Marking Criteria	Marks
<ul style="list-style-type: none">• Identifies the difference between male and female rates initially• Compared the change in rate over the time period.	2
<ul style="list-style-type: none">• Either of above correct	1

Initial lung cancer death rate in males was 3 times greater than that of females. Over the study period, death rate in males decreased by 20% while in females it remained relatively constant.

30 (a)

Marking Criteria	Marks
<ul style="list-style-type: none">• Correctly outlines 3 relevant steps in somatic cell nuclear transfer to produce cloned embryonic stem cells	3
<ul style="list-style-type: none">• 1-2 correct, relevant steps	1-2

1. Human skin cell is placed in special media to turn on expression of entire genome within the diploid nucleus.
2. An donor egg cell (ovum) is enucleated with a micro-pipette (haploid nucleus removed)
3. The nucleus of the skin cell is removed by micro-pipette and then injected into the enucleated ovum. The new cell is stimulated to start to divide to produce stem cells.

30 (b)

Marking Criteria	Marks
<ul style="list-style-type: none">• Correctly identifies an ethical issue of the research	1

Some individuals may have a moral dilemma of production and destruction of potential human embryos vs. the possibility of treating many diseases and saving lives.

Some religious individuals may be morally against any use of reproductive tissue except for natural child birth.

30 (c)

Marking Criteria	Marks
<ul style="list-style-type: none"> Identifies that transplants from cloned embryonic stem cells are genetically identical to the recipient's cells. Links this to the similarity of antigenic determinants on these stem cells and recipient's cells Explains that this would prevent an immune response which could lead to organ rejection Contrasts this with the use of genetically different IVF derived stem cells 	4
<ul style="list-style-type: none"> 1-3 of above points 	1-3

Transplants produced from cloned embryonic stem cells are genetically identical to the recipient's cell. Thus they will carry the same antigenic determinants on their cell surfaces and so will not trigger an immune response that could cause organ rejection. That is, the recipient's immune system will recognize cloned embryonic stem cell tissues as "self". In contrast, IVF derived stem cells are genetically different and may trigger the patient's immune system to reject the transplant.

31

Marking Criteria	Marks
<ul style="list-style-type: none"> 1 correct distinguishing feature and 1 disease example for each pathogen (4 correct pieces of information) Fully enclosed suitable table 	4
<ul style="list-style-type: none"> 1-3 correct pieces of information 	1-3

Pathogen	Distinguishing Feature	Disease caused by Pathogen
Prion	Abnormal protein particle	BSE-Mad cow disease, Creutzfeld-Jacob Disease (CJD), Scrapie, Kuru
Virus	DNA or RNA enclosed in a protein coat	HIV-AIDS, Measles, Chicken Pox, Polio, Influenza, Small Pox

Marking Criteria	Marks
Evaluates the validity of the model procedure by showing how the model simulates <ul style="list-style-type: none"> • Variation in a species population • Selecting agents and survival criteria • Reproduction • Change in population characteristics Evaluates the reliability of the procedure by <ul style="list-style-type: none"> • analyzing the results after many repetitions • analyzing the results of a number of groups Provides a final judgment of the model based on criteria	6-7
<ul style="list-style-type: none"> • 1-5 of the above criteria 	1-5

The model used was a very valuable learning tool because it validly and reliably demonstrated the process of natural selection and was simple and quick to perform.

1. A population of one species of lizard was represented with 30 cards. There were initially 10 red, 10 orange and 10 yellow to simulate **variation** of scale colour in the species. Initially equal numbers of variants existed.
2. **Reproduction** was simulated by shuffling the 30 cards and randomly pairing them to produce 15 parent pairs. The colour of the single offspring was determined by set “genetic rules” based on parent colours and use of a dice if alternate colours were possible.
3. The total population of 45 was then subjected to **predation (a selecting agent in the environment)**. A throw of the dice determined the colour lizard removed from the population by the predator. The chance of predation was weighted in a ratio of **3 red: 2 orange: 1 yellow**. 15 throws of the dice removed 15 lizards to return the population to 30. The number of each colour that survived was then recorded.
4. A minimum of 5 rounds of reproduction and predation were performed and the resulting number of variants recorded each time
5. The proportion of coloured lizards in the population was found to gradually change over the 5 plus rounds of predation with red eventually disappearing from the population.
6. The 6 groups that all performed the model all found the same pattern of red lizard extinction.

The model validly demonstrates natural selection by showing

- Variation in the population
- A selecting agent operating
- Survival of individuals with advantageous features (yellow colour)
- The inheritance of these favourable characteristics
- The gradual change in colour proportions in the population to mainly yellow

The model was reliable because

- A large number of reproduction and predation cycles were carried out and the trend became evident
- Similar results were reproduced by all groups performing the model

Thus the model validly and reliably demonstrated the process of natural selection and so is a useful learning tool.

Section II
Communication Option

33 (a)

Marking Criteria	Marks
Explains that the Stimulus - Response pathway controlling pupil size includes the following: <ul style="list-style-type: none"> • Light stimulus is detected by photoreceptors • Nerve impulses are generated and transmitted along neurones to the brain and from the brain to the effector • The brain/CNS initiates responses in effectors • The iris is the effector muscle which controls the size of the pupil 	4
<ul style="list-style-type: none"> • 1-3 above point 	1-3

This is a pupil reflex response which protects the retina from excessive light. The light stimulus is detected by photoreceptors in the retina. This generates a nerve impulse in sensory neurons within the optic nerve which travel to the CNS/brain. The brain /CNS initiates nerve impulses along motor neurons which stimulate the iris (effector muscle) to constrict the pupil(response).

33 (b)

Marking Criteria	Marks
<ul style="list-style-type: none"> • Identifies the range of wavelengths of the EM spectrum detected by humans and one other animal • Provides reasons for human range of detection • Provides reasons for chosen animal range of detection 	3
<ul style="list-style-type: none"> • 1-2 of the above points 	1-2

Humans can detect the range 380-750nm within the EM spectrum, ie. visible light whereas the Honey Bee detects 300-650nm, ie ultraviolet plus visible light. Both animals are active during the day. Humans use their range of colour vision to distinguish foods and get a detailed and precise image of their environment. Honey bees use the UV marking on flowers to find pollen and nectar.

33(c)

Marking Criteria	Marks
<ul style="list-style-type: none"> • Describes cataracts • Identifies lens replacement technology used to treat condition • Briefly describes procedure for lens replacement 	3
<ul style="list-style-type: none"> • 1-2 of the above points 	1-2

Cataracts are a clouding of the lens which initially decreases the clarity of vision and eventually causes functional blindness.

The treatment of the condition involves the replacement of the lens with an artificial lens or intraocular lens (IOL)

The technology to treat cataracts involves a simple surgical procedure under local anaesthetic. The cloudy lens is removed (aspirated) after first breaking it up with ultrasonic sound waves. An IOL replaces it. The small incision usually makes stitches unnecessary.

33 (d)

Marking Criteria	Marks
<ul style="list-style-type: none"> • Describes the process of accommodation • Explains its importance for visual communication • Provides examples • Identifies the shape of the lens for near vision and for distant vision • Describes the role of the ciliary muscle and suspensory ligament in altering the shape of the lens. 	5
<ul style="list-style-type: none"> • 1-4 of the above points 	1-4

Accommodation involves the changing of the curvature or shape of the lens to adjust for near and distant vision.

Without accommodation the eye would have a fixed focus and would be unable to change its focus to clearly see distant as well as close objects. This is essential for normal function eg. close work such as reading and identifying distant figures.

Near vision requires a rounded lens with maximum refractive power. This is achieved by the ciliary muscles constricting which causes the suspensory ligaments to loosen and so allow the lens to become more rounded.

Distant vision requires a less rounded, flatter lens with minimum refractive power. This is achieved by the ciliary muscle relaxing and pulling the suspensory ligaments taut. These in turn pull the lens into a thinner shape.