



2007

TRIAL HSC EXAMINATION

BIOLOGY

GENERAL INSTRUCTIONS

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board approved calculators may be used
- Write your student number on the answer booklet

Section I Pages 2-16

75 marks

This section has two parts, Part A and Part B

Part A- 15 marks

- Attempt Questions 1-15
- Allow about 30 minutes for this part

Part B- 60 marks

- Attempt Question 16-26
- Allow about 1 hour and 45 minutes for this part

Section II Page 17

25 marks

- Attempt all questions in 'Genetics: the code broken' in separate answer book
- Allow about 45 minutes for this section.

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Select the alternative A,B,C or D that best answers the question and place a cross in the appropriate box on the answer sheet table.

1. As blood passes through the kidneys there is a change in its chemical composition. Which substance below would you expect its concentration to remain constant as it passes into and out of the kidneys?

- A. urea
- B. salts
- C. Carbon dioxide
- D. Glucose.

2. What effect will the release of ADH into the bloodstream have?

- A. concentration of solutes in the blood will be decreased
- B. concentration of solutes in the blood will be increased
- C. increased reabsorption of sodium ions
- D. increased reabsorption of potassium ions

3. What is the effect of decreasing the concentration of carbon dioxide on the pH of water?

- A. A lowering of the pH, making it more alkaline
- B. A rise in the pH, making it less acidic.
- C. A rise in the pH, making it more alkaline
- D. A lowering of the pH, making it more acidic.

4. Which correctly identifies where active transport occurs in the nephron?

- A. the glomerulus
- B. the tubule
- C. the collecting duct
- D. the Bowman's capsule

5. Which type of animal below would be the most likely to excrete uric acid as its major nitrogenous waste product?

- A. Freshwater Fish
- B. Marine Fish
- C. Terrestrial mammal
- D. Insect.

6. Pyrethrum is a naturally occurring insecticide used to kill insects. Within a few years of the introduction of this chemical, some populations of insects have become resistant to this insecticide. This has occurred because

- A. Pyrethrum has caused the caterpillars to adapt and become resistant
- B. Caterpillars have acquired resistance to the insecticide over time
- C. Caterpillars have become immune to the insecticide with repeated exposure
- D. Caterpillars naturally resistant to pyrethrum have reproduced successfully

7. Himalayan rabbits are normally white with black ears, nose, feet and tail. The ears, nose, feet and tail have a lower temperature than the rest of the body. However, if a patch of fur is plucked from its back, and an ice pack is kept on the plucked patch, the new fur that grows there will be black too. Which is the best explanation for this observation?

- A. that lower temperatures cause mutations in cells which then produce black pigment
- B. the genotype for white fur is affected by lower temperatures
- C. genes for pigment production are switched on at lower temperatures
- D. codominant alleles are both expressed in these cooler areas

8. Both parents are heterozygous carriers of a recessive gene 'a'. What is the probability that their child will inherit the gene 'a'?

- A. $\frac{3}{4}$
- B. $\frac{1}{2}$
- C. $\frac{1}{4}$
- D. 0

9. The gene for haemophilia is recessive and carried on the 'X' chromosome. Which of the following best represent the children of a normal male and a normal female who carries the gene for haemophilia?

- A. 2 normal females : 2 haemophiliac males
- B. 1 normal female : 1 haemophiliac female : 1 normal male : 1 haemophiliac male
- C. 2 normal females : 1 normal male : 1 haemophiliac male
- D. 2 normal females : 2 normal males

10. Which genotype illustrates codominance of alleles that control blood type in humans?

- A. ii
- B. $I^A i$
- C. $I^A I^B$
- D. $I^B I^B$

11. Which pathogens below are not eukaryotic?

- A. Prions and viruses
- B. Fungi and viruses
- C. Bacteria and macroparasites
- D. Bacteria and protozoans

12. Which is not a first line defense barrier to prevent the entry of pathogens?

- A. stomach acid
- B. mucous membranes
- C. cilia
- D. lymph

13. Certain substances can pass through the placenta from a mother to her unborn baby. The fact that some babies are born addicted to heroin is the result of

- A. an inherited disease
- B. an environmental disease
- C. a nutritional disease
- D. an infectious disease

14. Many new products called 'probiotics' are being sold. They contain mainly bacteria that are beneficial to health. These 'probiotics' could be given to people

- A. who have taken antibiotics and as a result have an imbalance of microflora
- B. with an inadequate intake of vitamins and as a result has a deficiency disease
- C. who need a boost to their immune system and stimulate antibody production
- D. to assist their first line of defense and quickly respond to an antigen

15. 'These cells remain in the body for a long time and when required can quickly produce large amounts of an antibody'

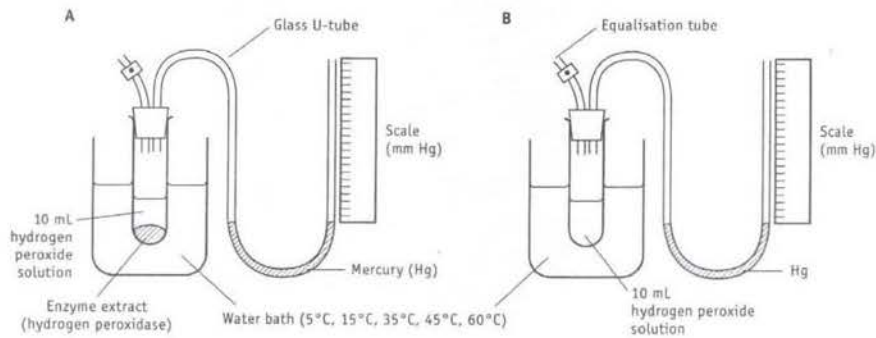
Which cell below could be described in this way?

- A. Helper T cells
- B. Suppressor T cells
- C. Memory B cells
- D. Memory T cells

Question 18 (8 marks)

MARKS

The following experiment was carried out to investigate the action of an enzyme over a given temperature range. Five different temperatures were used, they were 5°C then 15°C then 35°C then 45°C and lastly 60°C.



The enzyme (hydrogen peroxidase) speeds up the following reaction:



(a) What was the purpose of the equipment set up in diagram B? 1

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(b) What factors were the controlled variables between diagram A and B? 1

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(c) How does the production of oxygen gas in diagram A result in a reading in mm Hg on the scale? 1

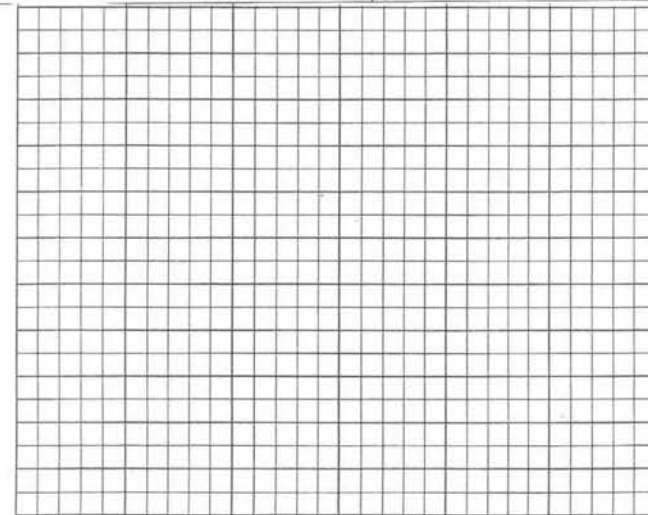
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(d) Data was collected from the equipment shown in diagram A and tabulated below. Draw a line graph of this data. 3

Temperature (°C)	Enzyme Activity (mm Hg)
5	8
15	20
35	48
45	15
60	3



(e) From the graph 1

(i) determine the enzyme activity at 25°C

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(ii) the temperature at which an enzyme activity of 10 mm Hg is obtained.

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(f) How do you account for the low enzyme activity at 60°C. 1

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Question 19 (4 marks)

MARKS
4

In a model of DNA replication each new DNA molecule will contain one DNA strand from the original DNA after replication. Use a diagram to explain this statement, clearly distinguishing the original and the new DNA strands during the process of replication.

Question 20 (6 marks)

MARKS

According to the theory of evolution, living organisms have undergone change since life arose on Earth. Identify three different types of evidence for evolution. Describe each of these evidences using specific named examples that support this theory.

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Question 21 (7 marks)

MARKS

(a) In the space below construct a pedigree that represents the data about the inheritance of red hair in the Smith family. 3

Mr. and Mrs. Smith have five children. Mr. Smith has brown hair and Mrs. Smith's hair is red. Their first two and last children are boys, the third and fourth are girls. The oldest son John marries a woman who, like John and his father, has brown hair. They have three children. The first and second children are both girls and have brown hair. However, the third child is a male who has red hair. The Smith's youngest son Pete, who has red hair, marries a woman, with brown hair. Their first child is a girl with brown hair and the second is a son with red hair.

(b) From the information in the pedigree identify the type of inheritance for red hair represented by this data, (dominant or recessive; sex-linked or autosomal) and give reasons 4

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Question 22 (3 marks)

MARKS

Compare the reproductive technologies:
- artificial insemination
- artificial pollination

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and their ability to alter the genetic composition of a population.

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Question 23 (4 marks)

MARKS

A gardener came across some leaves on a well-established native fig plant which had powdery grey patches on its leaves. Unaffected leaves were a glossy dark green. He took some of the affected leaves to a nursery and was advised to spray with a fungicide. However before doing so he wanted to identify the cause of the disease.

Using Koch's postulates, explain the steps the gardener should take to identify that the spots on the leaves are caused by a fungus.

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Question 24 (2 marks)

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After an organ transplant surgery patients are given drugs to suppress the immune response. Explain why an organ transplant triggers the immune system.

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Question 27

Genetics: The Code Broken? (25 Marks)

MARKS

(a) (i) Cross-breeding experiments can identify the relative position of linked genes. The table shows the percentage recombination rates for four genes, P, Q, R and S, on a single chromosome. 2

	P	Q	R	S
P	-	30	10	5
Q	30	-	40	25
R	10	40	-	15
S	5	25	15	-

From this data, draw a simple chromosome map showing the relative locations of these four genes.

(ii) Outline how chromosome mapping can help to identify relationships between species? 2

(b) What is meant by a gene homologue and how can they provide evidence for evolution, discuss using examples. 5

(c) (i) A man who is Rh⁺ and has blood group A marries a woman who is Rh⁺ and has blood group B. They produce offspring in the ratio: 3

25% AB Rh⁻, 25% A Rh⁺, 25% B Rh⁺, and 25% O Rh⁺

What are the genotypes of the woman and her husband? Assume these genes are not linked. Show all working.

(d) Explain how the structure of genes controls the function of a cell. 7

(e) Describe using an example the role of a gene cascade. 4

(f) Distinguish between polyploidy and trisomy. 2

END OF TEST

Marking Guidelines: Biology 2007

Question	Answer
1	D
2	A
3	B
4	B
5	D
6	D
7	C
8	A
9	C
10	C
11	A
12	D
13	B
14	A
15	C

16 (a)

Marks	Criteria
1	Function of device

Answer:

Allows the measurement of oxygen concentration in the blood.

(b)

Marks	Criteria
1	Condition in which it may be used

Answer:

When conditions require a non-invasive, rapid monitoring eg. through anaesthesia and in intensive care units during mechanical ventilation, when checking the body's response to different medications or to monitor a person with asthma or who is having trouble breathing

(c)

Marks	Criteria
1	Explain how light passes through finger to photodetector
1	Explain how the amount of light passing through is affected by the amount of oxygen absorbed by haemoglobin

Answer:

A small clip with a sensor is attached to the person's finger, earlobe or toe. A cable connects the sensor to the pulse oximeter machine. The colour of the blood changes according to the amount of oxygen that is dissolved in the blood. Blood that is high in oxygen is bright red while blood low in oxygen is a darker colour. The sensor emits a light- red and infrared light signal that passes through the skin. The sensor measures the amount of light absorbed as it passes through the tissue and blood, and transmits the information to the photodetector. A reading is given in a percentage form.

17.

Marks	Criteria
2	List of equipment- must include animal kidney and instruments
1	Safety Precaution
2	Method-step by step include internal and external observations and drawings
3	Labeled diagram-internal, external(optional)

Answer:

List of Equipment:

- *Sheep's kidney
- *dissecting tray/newspaper
- *dissecting instruments-scalpel, scissors, probe, forceps.
- *disposable gloves

Safety precaution:

Safety when using the scalpel- keep fingers clear of the blade and cut away from yourself or

Hygienic practices -wearing gloves, washing hands when finished with soap and water as the kidney may contain pathogens.

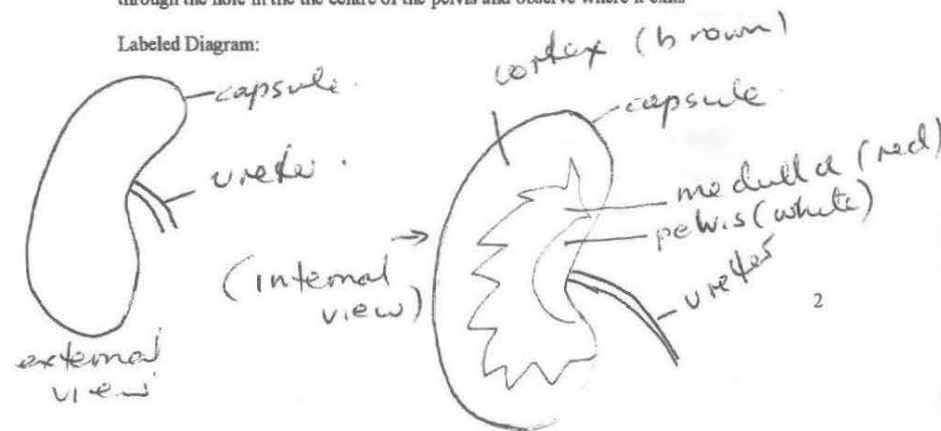
Method:

*Place kidney in dissection tray and observe and draw the outside of the kidney-shape and any tubes from the concave surface

*Use a scalpel to cut a longitudinal section, opening out the two halves

*Draw the internal structures-cortex, medulla, pelvis, opening to the ureter-insert a probe through the hole in the the centre of the pelvis and observe where it exits

Labeled Diagram:



18.(a)

Marks	Criteria
1	Purpose of B - control

Answer:

The control- to check that it is the enzyme activity producing the results.

(b)

Marks	Criteria
1	Identify at least 2 controlled variables

Answer:

Volume of hydrogen peroxide solution, temperature of water bath, identical apparatus

(c)

Marks	Criteria
1	Correct explanation

Answer:

Oxygen builds up in the test tube and puts pressure on the mercury column, pushing it up the scale.

(d)

Marks	Criteria
1	Correctly labeled axes with correct units
1	Correctly plotted points
1	Curve of best fit drawn

Answer:

PTO

(e)

Marks	Criteria
1	Both correct answers from graph

Answer:

(i) 35°C

(ii) 7°C, 50°C

(f)

Marks	Criteria
1	Explanation of low enzyme activity

Answer:

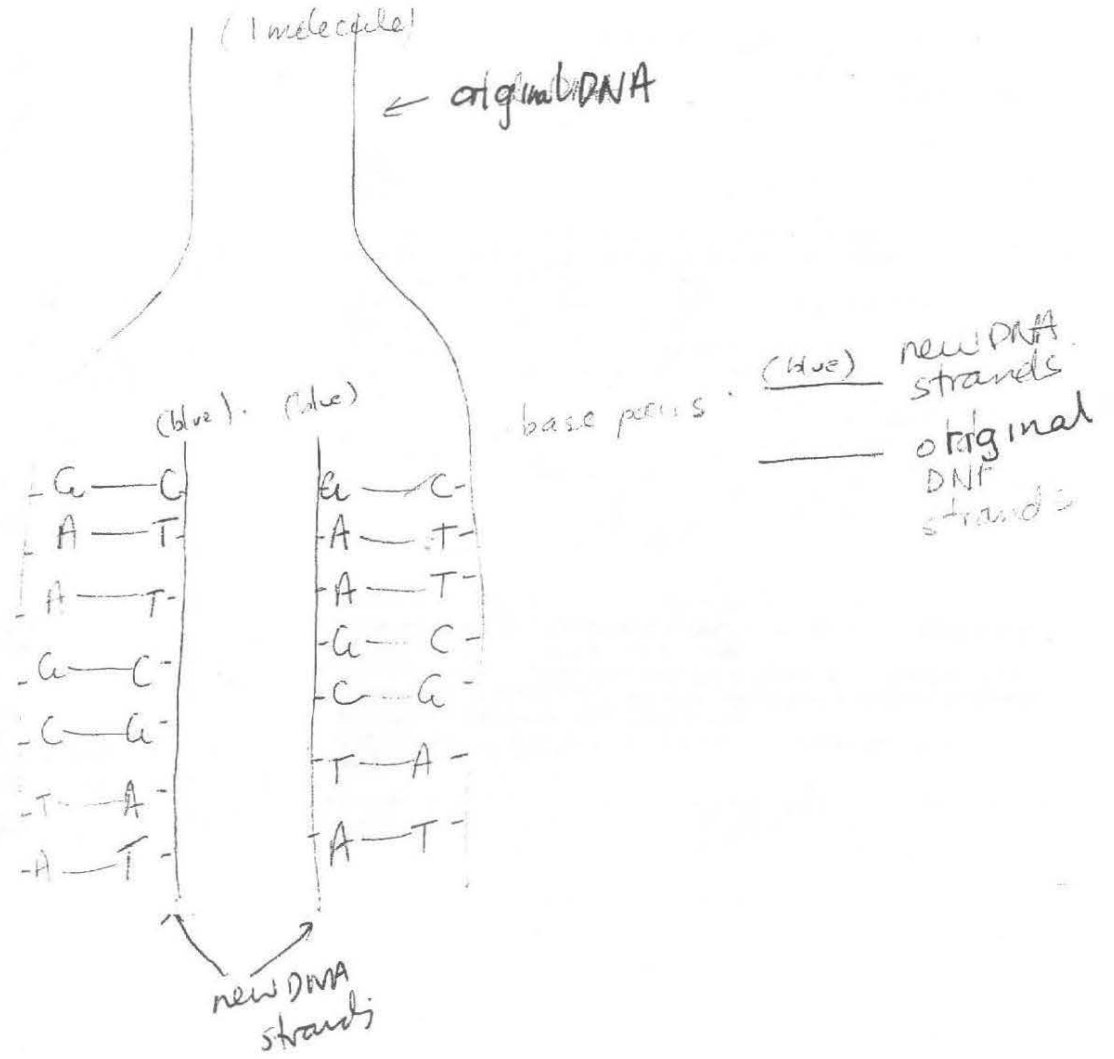
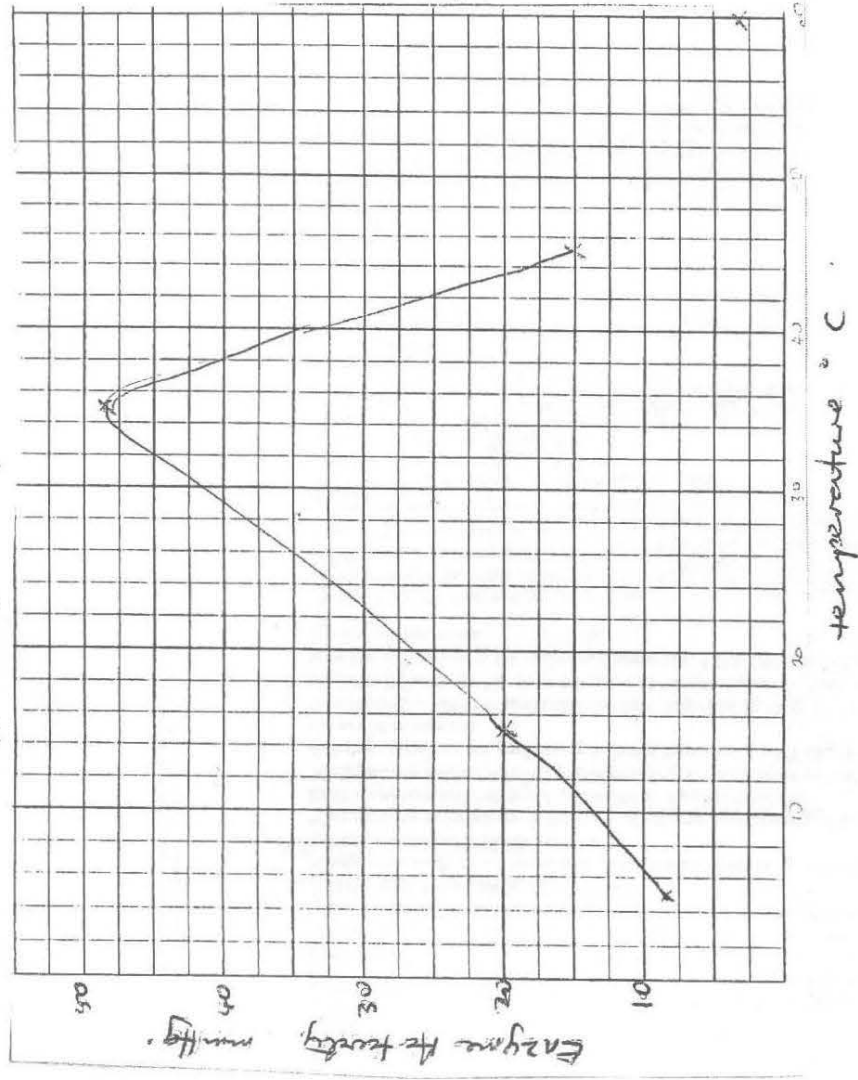
Enzyme denaturation.

19.

Marks	Criteria
1	Double stranded nature of DNA
1	Model includes correct pairing of bases shown
1	Two labelled double helices shown
1	Clearly shows the difference between the original and new DNA

PTO

Affect of Temperature on Enzyme Activity



20.

Marks	Criteria
3	Identify and describe 3 different evidences
3	Named example of each evidence

Answer: Any 3

*Palaeontology-study of fossils, shows the gradual changes in horses over the past 50 million years from dog like size to present size. Also transitional forms such as Archeopteryx had reptile and bird features

*Biography- study of the worldwide distribution of species eg. emus unique to Australia and turkeys unique to North America

*Comparative embryology- is the study of embryo development of different species eg. Early stage vertebrate embryos are similar as they have gill slits

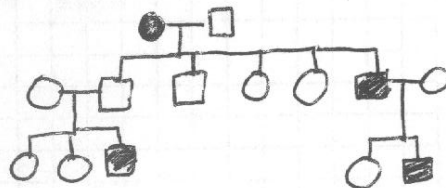
*Comparative anatomy-show homologous features with the same basic plan found in different organisms but performing different functions eg pentadactyl limb in different classes of vertebrates.

*Biochemistry- study of molecules and how they react eg study of the amino acid sequence of haemoglobin show humans and chimpanzees are closely related as there are very few differences in the amino acid sequence., DNA-DNA hybridisation also confirms this close relationship.

21. (a)

Marks	Criteria
3	Pedigree correctly constructed and, based on data. One mark off for each mistake.

Answer:



■ = red hair male

○ = female

21(b)

Marks	Criteria
1	Recessive
1	Reason for recessive
1	Autosomal
1	Reason for autosomal

Answer:

Recessive- in generation II, the first two parents who do not have red hair have produced children, some have red hair and some do not. Therefore both parents must be heterozygous and brown hair is dominant

Autosomal-If red hair was sex-linked the female in the first generation would be homozygous and all of her sons would be red haired and this is not the case.

22

Mark	Criteria
2	Two similarities
1	One difference

Answer:

Artificial insemination is a reproductive technique used in animals and artificial pollination is a reproductive technique used in plants

Artificial insemination and artificial pollination both speed up the changes in the genetic make-up of a particular species to suit the breeder's requirements.(eg high milk production in cows, different flower colour in plant)

Continued use of a limited genetic pool can reduce genetic diversity in plants or animals can cause problems if environmental conditions change.

23.

Marks	Criteria
1	Microorganism must be present in every case
1	Culture to isolate microorganism-describe features
1	Use pure culture to inoculate healthy leaf
1	Recover microorganism from new host and grow pure culture-same features as original

Answer:

Examine all infected leaves -All affected plants must have the same powdery grey patches- the suspected microorganism must be present in all cases

make a pure culture of the suspect organism

infect healthy leaves with sample from the pure culture and the leaves should get the same powdery grey patches as the original leaves

isolate the microorganism from the second batch of leaves and grow in a pure culture and show it is identical in features to the first culture.(eg same colour, shape of colony)

24

Marks	Criteria
1	Explanation includes the antigens on the non-self tissue
1	T cell identify foreign antigens attacking the tissue/ production of antibodies in response to antigens

Answer:

Molecules in the transplanted tissue may be treated as antigens by the body and cause an immune response, including antibodies and T cells attacking the tissue and causing rejection of the transplanted tissue. These molecules (MHC-major histocompatibility proteins are highly variable between individuals and would be recognised as non-self.

25

Marks	Criteria
1	hypothesis
3	Method, labeled diagrams
1	results
2	conclusion

Answer:

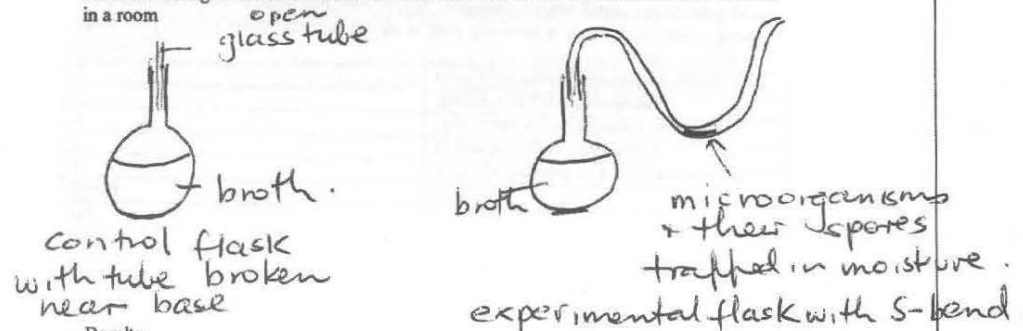
Hypothesis: Broth(soup) would spoil and become contaminated with bacteria and moulds caused by spores entering the broth in the air.(or microbes present in the air and not air alone cause decay in the soup)

Method:

*Pasteur placed broth into two different glass flasks

*One flask had a top that was a long S-bend while the other had the S-bend broken off near the base (the control). The S-bend allowed air to enter but spores of bacteria and mould became trapped in the liquid in the S- bend and could not enter the flask.

*Pasteur boiled the broth in each flask to kill any microorganisms in the broth. The steam from the boiling sterilised the walls of the flasks. Both flasks were then allowed to stand in a room



Results:

The flask with the S-bend broken near the base (the control) quickly developed bacteria and mould on the surface. The broth spoiled.

The broth in the flask with the S-bend did not spoil. Bacteria and mould did not form on the broth.

Conclusion:

Microorganisms were responsible for the spoiling of the broth. When microorganisms were not present the broth did not spoil.

7

Microorganisms did not spontaneously generate. There had to be microorganisms or their spores for them to occur.(disproving the theory of spontaneous generation)

26(a)

Marks	Criteria
1	Correctly explains why polio can't be treated with antibiotics

Answer: Polio is a viral disease , antibiotics only affect bacteria. Therefore, not effective.
(b)

Marks	Criteria
1	Content of the vaccine
1	Antigens induce the immune response
1	Effect of immune response
1	Effect of subsequent infection

Answer:

The vaccine which is introduced into the body contains live attenuated strain of the polio pathogen. Its antigens induce the immune response(without disease symptoms) and specific antibodies are produced and memory T and B cells producing immunity. If the polio virus enters the body, more antibodies will be produced very rapidly preventing the infection and giving resistance to the disease.

(c)

Marks	Criteria
1	Uses the data
1	Vaccination extremely effective

Answer:

The polio vaccine is extremely effective as the numbers of new cases dramatically fell to 0 when the whole population was immunised because there was no reservoir of infection.

Genetics the Code Broken:

(a) (i)

Marks	Criteria
1	Correct order of the genes
1	Correct relative distance between the genes

Answer:



(a)(ii)

Marks	Criteria
1	Chromosome mapping similarities reflects the degree of relatedness of species
1	The more similar maps the closer the relationship

8

Answer: If two species are very closely related, then their chromosome maps will be very similar, that is the relative order of genes on their chromosomes
 Chimpanzees have the most in common with human chromosomes. This suggests that humans and chimpanzees had a common ancestor in quite recent times. Species more distantly related may have different order of the genes and possibly some genes may not be linked.

(b)

Marks	Criteria
1	State the meaning of a gene homologue
1	Example of gene homologue
1	How it shows evolutionary relationship
1	Example of gene homologue
1	How it shows evolutionary relationship

Answer:

There are DNA sequences that are similar in their functions in many organisms. These DNA sequences are called homologue genes, homeobox or Hox genes. Often these genes regulate the development of an organism by producing proteins that switch other genes on and off.

Their similarity suggests these genes evolved in a common ancestor. The greater the similarity in the genes the more recent in time the common ancestor.

*An example of a homologue is the gene cascade for skeletal and neurological development in limbs. It is similar in organisms such as humans, chickens, rodents, insects, nematodes and molluscs.

*Experiments have confirmed that the homologue gene from an amphibian can regulate the corresponding gene in mammals.

*Many DNA repair genes are similar in a large number of species

*The genes producing cytochrome c (a respiratory protein) are homologues, comparing DNA sequences in different species is useful for determining degree of relatedness.

*A HOX gene inserted into a vertebrate from a lower animal can perform the same regulatory function as the vertebrates own HOX genes. Eg The gene that produce eyes in mice is so similar to the equivalent gene in insects that the genes can be interchanged and still function correctly (PAX-6 gene)

(c)

Marks	Criteria
1	Correct genotype of one parent
1	Correct genotype of other parent
1	Correct working

Genotype parents: $I^B i$ $Rh^+ Rh^-$
 $I^A i$ $Rh^+ Rh^-$

Answer:

	I^A	i	
I^B	$I^A I^B$	$I^B i$	
i	$I^A i$	ii	
			Rh^+ Rh^-
			$Rh^+ Rh^+$ $Rh^+ Rh^-$
			$Rh^- Rh^+$ $Rh^- Rh^-$

(d)

Marks	Criteria
1	DNA code → mRNA-transcription
1	mRNA → ribosome
1	translation
1	Polypeptide → protein
1	Gene expression
1	How gene expression is controlled
1	How protein controls cell

Answer:

*The sequence of bases along a DNA molecule determines the polypeptide and ultimately the protein that is produced by a cell and therefore the function of that cell
 During transcription, messenger RNA takes a complimentary copy of the template strand of the unzipped DNA molecule.

*The mRNA moves out of the nucleus into the cytoplasm and attaches to a ribosome.

*tRNA molecules load an appropriate amino acid and delivers this to the mRNA
 The ribosome moves along the mRNA placing the amino acids in sequence until a stop codon is reached.

*Peptide bonds form between the amino acids which then form a polypeptide.
 Polypeptides may then join to make a more complex protein.

*Gene expression refers to a gene being switched on to produce a polypeptide. At any one time only some genes are expressed.

*They can be switched on and off by various mechanisms eg DNA in the nucleus of cells is a tightly wound molecule, the parts that are highly condensed are genes that are switched off.

*The genes that are switched on may code for polypeptides and ultimately proteins that have various functions eg. may be an enzyme, or structural protein or carry oxygen like haemoglobin., thus determining the function of that cell.

(e)

Marks	Criteria
1	Define gene cascade
1	Example of gene cascade
2	Explanation of need for gene cascade
1	Explanation of how it works

Answer:

*A gene cascade is a sequence of gene expression during the development of the embryo. It causes events to occur in a particular order.

*During limb development in birds and mammals, an appropriate sequence of genes *is turned on to form such things as bones, muscles, ligaments, tendons, nerves and blood vessels. As each gene is turned on, certain substances are produced that turn on the next gene in the sequence. This process is repeated and continues as the limb develops.
*This process of a sequence of on which genes being turned then causes other genes to be turned on is an example of a gene cascade.

Homeotic genes set in motion the development of tissues from head to tail, upper limb to lower limb, base of the limbs to tips of the limbs and the sequential pattern of tissue, bone, muscle, nerves, and blood vessels. As a result many genes are switched on in the right sequence.

(f)

Marks	Criteria
1	Correctly defines polyploidy
1	Correctly defines trisomy clearly indicating difference

Answer:

Polyploidy occurs when cells contain more than two sets (2N) of chromosomes eg tetraploid (4N).

Trisomy is the presence of three copies of a homologous chromosome rather than the normal two copies eg Down Syndrome-trisomy 21, have 47 chromosomes instead of 46.