

**JAMES RUSE AGRICULTURAL HIGH SCHOOL
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION
2005**

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 at the top of pages 9, 13, 17, 21 and 33**

Total marks – 100

Section I – 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 Questions 16-27**
- **Allow about 1 hour and 45 minutes for this part**

Section II – 25 marks - Question 28

- **Allow about 45 minutes for this section**

Section I
75 marks

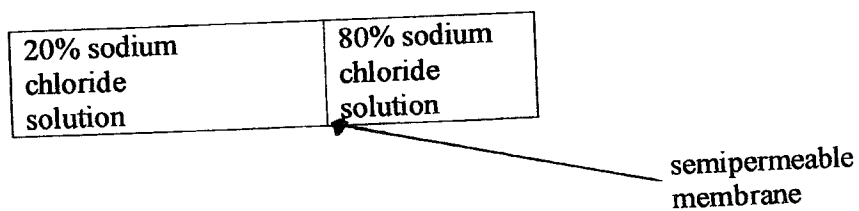
Part A – 15 marks
Attempt Questions 1-15
Allow about 30 minutes for this part

1. Which statement correctly describes white blood cells?

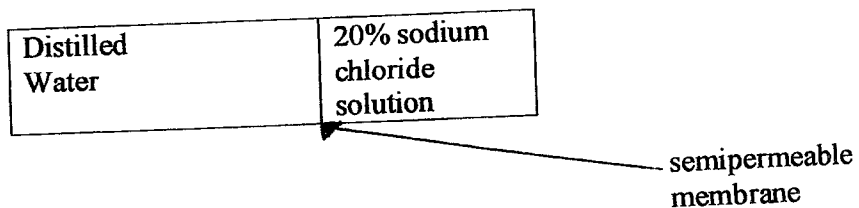
- A) smaller than red blood cells but more numerous
- B) smaller than red blood cells and fewer in number
- C) larger than red blood cells and fewer in number
- D) larger than red blood cells and more numerous

2. In which of the diagrams below would you expect water to enter the left hand compartment by osmosis?

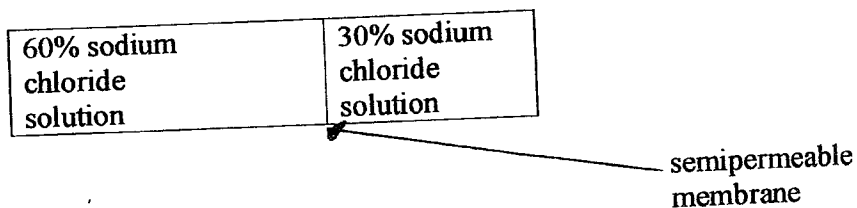
A)



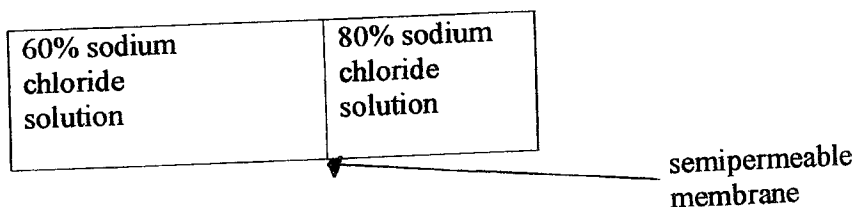
B)



C)



D)



3. Which alternative below most correctly describes the concentration of the listed substance in the blood leaving the kidney compared to its concentration in the blood entering the kidney?

	Urea	Glucose	Amino acids	Water	Drugs and other toxins
A)	Less	Less	More	Less	Less
B)	More	The same	The same	More	Less
C)	Less	The same	The same	Less	Less
D)	More	The same	Less	More	More

4. Which statement below correctly describes movement of materials in the phloem?
- A) Organic materials are actively loaded into the phloem sieve tube cell at the 'source' and then move passively along a pressure gradient to the 'sink' cells.
- B) Water and mineral ions move from roots to shoots passively
- C) Organic material moves passively from roots to shoots in a process called translocation
- D) Water and mineral ions move in all directions in the sieve tube cells, using both active and passive transport.
5. Why is the removal of wastes such as urea and carbon dioxide essential?
- A) Metabolic reactions cannot take place because the water increases cellular solute concentrations, causing water to move out of cells.
- B) Enzyme-controlled processes cannot be carried out properly because a build up of wastes increases cellular solute concentrations and alters other properties such as pH.
- C) Enzymes would not function properly because they would combine with the waste molecules instead of substrate molecules.
- D) Waste materials are used in respiration, producing too much heat inside cells.
6. Which of the following is the cause of malaria?
- A) a fungus
- B) a protozoan
- C) a virus
- D) a macro parasite
7. Which of the following best describes the process of immunisation?
- A) exposing an organism to a pathogen
- B) following a healthy lifestyle to promote natural immunity
- C) using antibiotics to fight an existing infection
- D) stimulating an immune response by introducing a new pathogen to an organism

8. Which of the following best describes antibodies?

- A) components of DNA
- B) a foreign body, that is part of a pathogen
- C) a type of phagocyte
- D) secreted by B cells

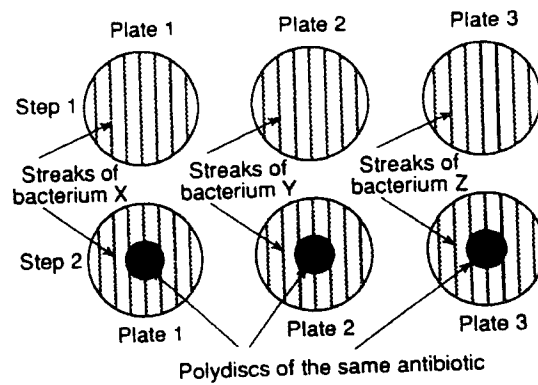
9. The diagram below shows one of our body's defences against disease.



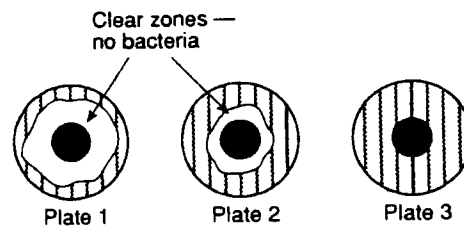
What are the parts of the diagram labelled X and Y?

	X	Y
(A)	T cell	B cell
(B)	antibody	micro organism
(C)	antigen	white blood cell
(D)	micro organism	antigen

10. In an experiment to study the effects of an antibiotic on bacterial growth, agar plates were set up as shown:



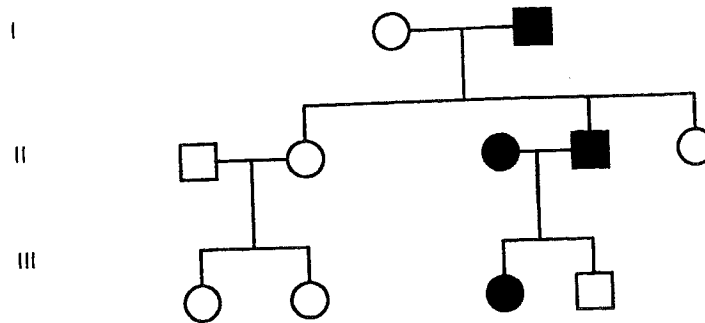
The plates were incubated at 37° for forty-eight hours. The diagrams of plates 1, 2 and 3 below show the results.



You could conclude from these results that:

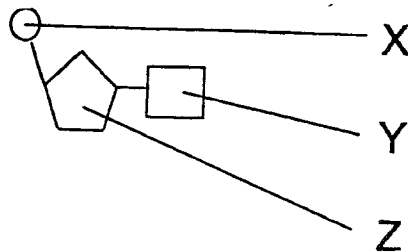
- (A) bacteria Z was not effectively controlled by the antibiotic used in the experiment
 - (B) the antibiotic for plate 1 was different to the antibiotic in plate 3.
 - (C) the incubation procedures for plate 3 must have been inadequate
 - (D) when bacteria compete it is likely that only the strongest will survive
11. Which one of the following is an example of convergent evolution?
- A) The different species of finch in the Galapagos islands which have adapted to their own particular environmental niches
 - B) The Thylacine of Tasmania and the wolf of the Northern hemisphere that are both adapted to a predatory lifestyle
 - C) The development of DDT resistant insects in farming areas
 - D) The rapid evolution of new species without the appearance of transitional forms
12. A section of DNA molecule is 30 base pairs long. What is the maximum number of amino acids this would code for?
- A) 6 amino acids
 - B) 15 amino acids
 - C) 20 amino acids
 - D) 10 amino acids

13. The pedigree below shows the inheritance of a certain disease in humans. Affected individuals are shaded.



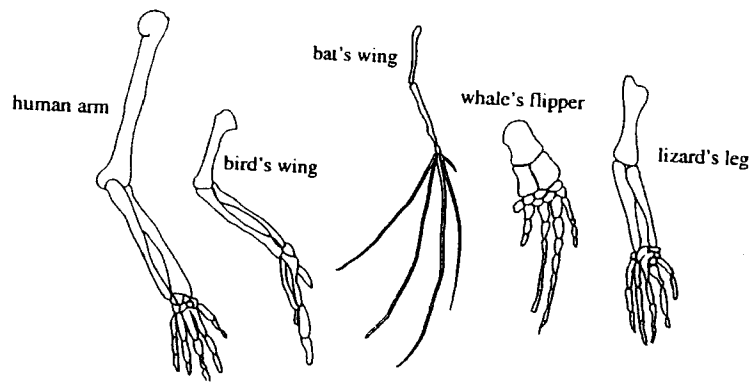
- Which of the following best describes the gene for this disease?
- A) non sex-linked and recessive
 - B) sex-linked and dominant
 - C) non sex-linked and dominant
 - D) sex-linked and recessive

14. Question 14 refers to the following diagram of a section of a DNA molecule.



- Which part(s) of the structure above are always the same?
- (A) X and Y
 - (B) X and Z
 - (C) Y and Z
 - (D) Y only

15. The diagram below shows the forelimbs of several different vertebrates.



What form of evidence is shown in the above diagram?

- A. homologous structures
- B. comparative embryology
- C. biochemistry
- D. transitional forms

Student Number.....

ANSWER SHEET

Select the alternative that best answers the question. Place a cross in the appropriate space.

SECTION I

PART A – 15 marks

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

SECTION I (continued)

Part B – 60 marks

Attempt Questions 16-27

Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided

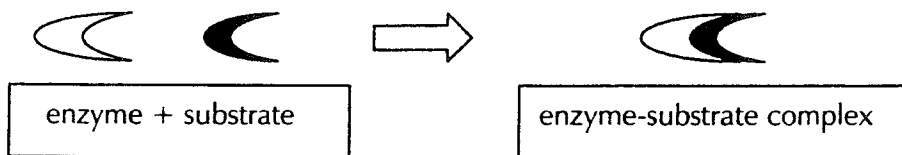
Marks
6

16.

Substance	Form in which it is carried in blood
Carbon dioxide	
Water	
Oxygen	
Mineral salts	
Nitrogenous waste	
Lipids	

17.a) Explain why the following is not an accurate representation of enzyme action.

2



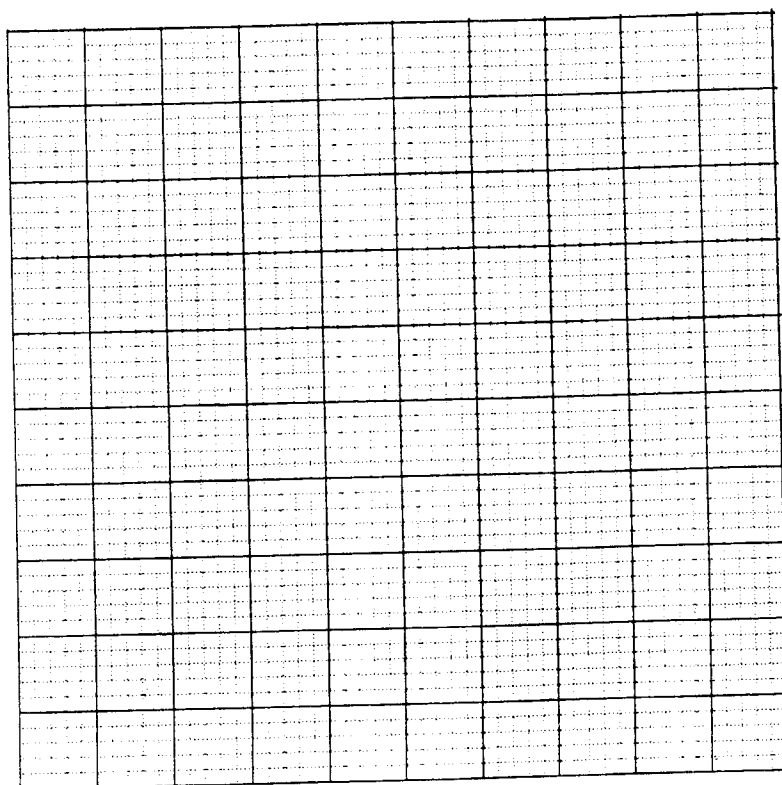
b) Redraw this model to give a better representation of enzyme action

(1)

18. The table below shows the activity of two different enzymes at different levels of acidity: (7 marks)

pH	Activity of enzyme A (% of maximum)	Activity of enzyme B (% of maximum)
1	0	50
2	30	97
3	70	24
4	90	6
5	95	0
6	60	0
7	0	0
8	0	0

a) On the same set of axes, plot the activity and draw graphs of each enzyme against pH. (3)



b) Describe the relationship between pH and enzyme activity for each enzyme (2)

c) One of the enzymes above is in fact a stomach protease, and one is the enzyme glucose oxidase (an enzyme used in respiration). Which enzyme, A or B, is the protease? Explain your answer. (1)

d) Use the terms 'dependent' and 'independent' to describe the variables involved in this investigation. (1)

4 marks

19. The table below compares the amount of urine produced as a percentage of bodyweight for different mammals and fish.

	Urine output as a percentage of		bodyweight
Human	Marine bony fish	Freshwater fish	Kangaroo rat
3%	3%	10%	1.5%

Explain the difference in these figures in terms of the environment of each animal.

3 marks

20. When you performed a first-hand investigation to identify microbes in food or water, describe the risk assessment you carried out, the potential hazards and how they were addressed.

21. Distinguish between a defence barrier and a defence adaptation. Identify one example of each in your answer. **2 marks**

22. **6 marks**

- (a) Explain what is meant by the "immune response." **2**

- (b) Name a scientist who improved our understanding of the immune response and outline the contribution that was made by this scientist. **2**

- (c) Explain why organ transplants should trigger an immune response. **2**

23.

Distinguish between:

(9 marks)

i)a) a prion and a virus

2

b) a protozoan and a macro parasite

2

c) a bacterium & a fungus

2

ii) Name one disease caused by each of these pathogens. Record your answer in a table.

3

24.

4 marks

Outline the contribution made by Beadle & Tatum to our current knowledge of genetics.

25.

5 marks

a) Colour-blindness is a sex-linked trait in humans. If two parents are not colour-blind, but the mother is a carrier for the condition, what is the chance of this couple producing a colour-blind child? Show working. 2

b) Describe the work of Thomas Morgan that led him to suggest the existence of sex linkage. 3

26.

4 marks

Explain the relationship between the structure and behaviour of chromosomes during meiosis and the inheritance of genes.

27.

7 marks

You have performed an investigation to construct pedigrees, tracing the inheritance of selected characteristics. From this investigation include:

a) the name of one characteristic you studied

1

b) the method you used to study the inheritance of the characteristic

2

c) a diagram of a pedigree showing the inheritance of this characteristic including a key

2

d) A conclusion as to whether the characteristic is dominant or recessive

1

e) A discussion of the current use of pedigrees

1

SECTION II Genetics: the code broken

Question 28 (25 marks)

Allow about 45 minutes for this section

Answer the question in a writing booklet

	Marks
a) A mother who is Rh ⁻ and with heterozygous blood Group AB and a father who is Rh ⁺ (whose own father was Rh ⁻) with heterozygous blood group O produce a number of offspring. Show their possible genotypes and phenotypes and include all working.	4
b) Distinguish between the terms 'trisomy' and 'polyploidy'	2
c) Outline the process by which DNA can repair itself.	3
d) Barbara McClintock's work on corn in the 1940's and 50's led her to propose that genes are transposable.	4
i) Describe what is meant by this term 'transposable' and how they operate	
ii) Discuss their impact on the genome	
e) The Human Genome Project is attempting to identify the position of genes on chromosomes.	8
i) Assess why the Human Genome project could not be achieved by studying linkage maps	
ii) Explain how recombinant DNA technology can identify the position of a gene on a chromosome.	
f) Distinguish between a germline and a somatic mutation and compare their effect on a species	4

End of Test

James Ruse Agricultural High School
2005 Biology Trial
Marking Guidelines

Section I

Part (A) Q1-15, 1 mark each

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

Part(B) Total marks 60

Q16 (6marks)

Criteria	Marks	Band
Correctly identifies 6 forms in which substances are carried in the blood.	6	4
Correctly identifies 5	5	4
Correctly identifies 4	4	3
Correctly identifies 3	3	3
Correctly identifies 2	2	2
Correctly identifies 1	1	2

Answer:

Substance	Form in which it is carried in blood
Carbon dioxide	carried as the ion HCO_3^- dissolved in plasma
Water	Carried as water molecules in plasma
Oxygen	Carried as oxyhaemoglobin in red blood cells
Mineral salts	Carried as ions dissolved in plasma
Nitrogenous wastes	Carried as urea dissolved in plasma
Lipids	Carried as chylomicron (have a protein coat) in lymph plasma

Q17 (3 Marks)

A)

Criteria	Marks	Band
A new product that is not combined to the enzyme should be shown and the enzyme free to be used again.	2	5
The enzyme should be able to be used again.	1	4

Answer: This is not an accurate representation of enzyme action as there is no new product and the enzyme is not free to be reused.

B)

Criteria	Marks	Band
The enzyme should be free and a new product formed.	1	4

Answer:

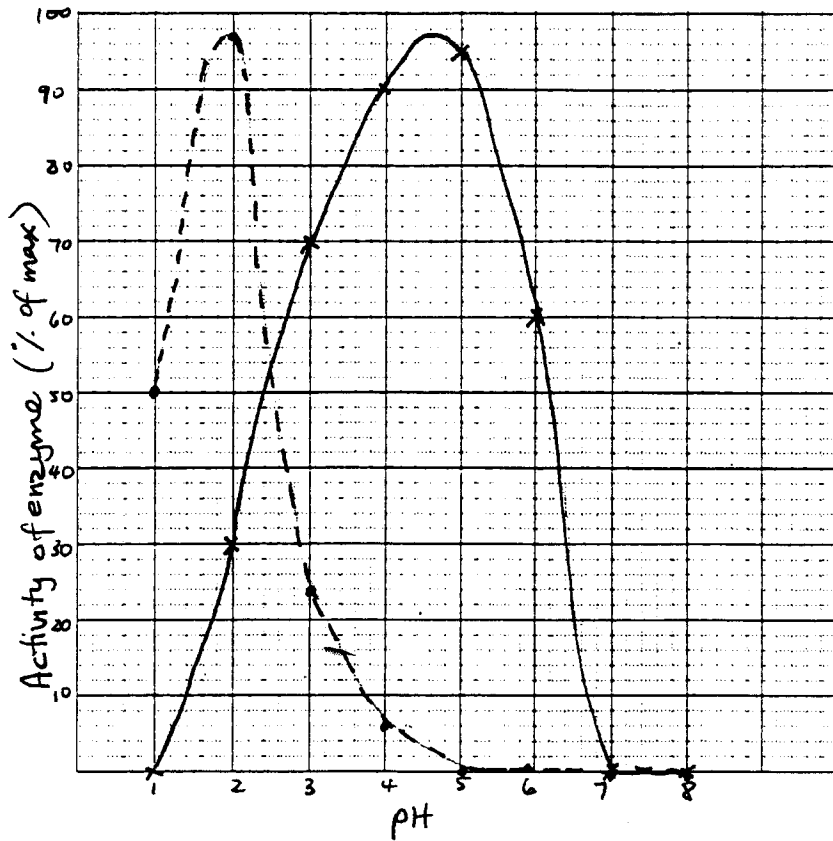


Q18 (7 Marks)

A)

Criteria	Marks	Band
Both axes labeled properly, points plotted accurately, graphs drawn and clearly distinguished	3	4
Points plotted accurately and graphs drawn	2	4
Graphs clearly distinguished as A and B	1	4

—x— = A
 - - • - - = B



B)

Criteria	Marks	Band
Correct explanation for both enzyme A and B	2	5
Correct explanation for enzyme A or B	1	4

Answer: The activity of enzyme A increases to a maximum or optimal level at pH 4.5-5 and decreases to zero at pH 7. The activity of enzyme B increases to a maximum at pH 2 and then decreases to zero at pH 5.

C)

Criteria	Marks	Band
The answer B and correct explanation	1	4

Answer: B is the protease because it's optimum pH is suited to the acidic conditions of the stomach.

D)

Criteria	Marks	Band
Correct description of both variables	1	5

Answer: The independent variable is pH and the dependent variable is activity of enzyme.

Q19 (4 Marks)

Criteria	Marks	Band
Correct explanation for all 4 animals	4	5
Correct explanation for 3 animals	3	4
Correct explanation for 2 animals	2	3
Correct explanation for 1	1	2

Answer: Both the human and the kangaroo rat are terrestrial animals and there is the need to conserve water by producing small amounts of relatively concentrated urine. The kangaroo rat is adapted to desert conditions where water is scarce and the more concentrated urine will allow for water conservation. Freshwater fish produce large amounts of dilute urine as a means of getting rid of the large volumes of water that tends to move into its body by osmosis. Saltwater fish have relatively small amounts of concentrated urine as water tends to move out of their bodies by osmosis.

Q20 (3Marks)

Criteria	Marks	Band
2 potential hazards identified, how each of these were addressed, risk assessment	3	6
1 potential hazard identified and how it was addressed, risk assessment	2	5
Risk assessment	1	4

Answer: The experiment to identify microbes in water involved growing microorganisms that may be pathogenic. Students washed their hands with soap and antiseptic solution before leaving the laboratory, after handling the plates containing the microbes. This was necessary to prevent the spread of a pathogen. The plates containing the microbes were sealed with sticky tape after the initial inoculation with water and not opened again. This was necessary to avoid possible infection and spread to other people. Risk assessment: the use of sterile techniques is essential in microbiological work to ensure that you do not become infected with potential pathogens grown and that the experiment does not become contaminated with organisms other than those being studied. By identifying hazards as mentioned and then addressing these hazards, personal protection is increased. The treatment and disposal of material such as the agar also involved sterilizing in a pressure cooker.

Q21. (2 Marks)

Criteria	Marks	Band
Difference between defence barrier and defence adaptation stated and example of each	2	6
Difference between defence barrier and defence adaptation or example of each	1	5

Answer: A defence barrier prevents the entry of pathogens eg. Skin, mucous membranes, cilia. If a pathogen penetrates these barriers then other second line of defence responses can take place eg. inflammation, phagocytosis.

Q22 (6 Marks)

A)

Criteria	Marks	Band
Explanation of the immune response as a specific defence and including the production of B cell, T cells and antibodies.	2	6
Explanation of this specific defence or the production of T cells, B cells and antibodies.	1	5

Answer: The immune response is a specific defence and includes the production of B cells which produce antibodies and T cells which can destroy cells identified as non-self.

B)

Criteria	Marks	Band
Name and contribution of scientist	2	6
Name or contribution of scientist	1	5

Answer: MacFarlane Burnet's contribution to immunology was in the development of the clonal selection theory of how the immune system works to destroy an antigen and helped to explain how the body identifies self and non-self.

C)

Criteria	Marks	Band
Explanation of 'non- self' aspect of organ transplants and involvement of T and B cells	2	6
Explanation of non-self aspect of organ transplant or the involvement of T and B cells	1	5

Answer: This is because the transplanted organ is recognized as an antigen by the T cells and B cells. Killer T cells and antibodies begin to attack the tissue that has been distinguished as non- self by the lymphocytes and tissue rejection often follows.

Q23. (9 Marks)

i)

A)

Criteria	Marks	Band
Difference between a prion and virus stated, mentioning both	2	5
Difference between a prion and and virus stated, mentioning only one	1	4

Answer: A prion is an infective protein and does not have nucleic acid. A virus contains nucleic acid surrounded by a protein coat.

B)

Criteria	Marks	Band
Difference between a protozoan and a macroparasite stated, mentioning both	2	5
Difference between a protozoan and macroparasite stated, mentioning only one	1	4

Answer: A protozoan is a single celled microscopic organism. A macroparasite is a multicellular organism that can be seen with the naked eye.

C)

Criteria	Marks	Band
Difference between bacteria and fungus stated, mentioning both	2	5
Difference between bacteria and fungus stated, mentioning only one	1	4

Answer: A bacterium is a prokaryotic and single celled organisms (no membrane-bound organelles or nucleus). A fungus is eukaryotic and can be unicellular or multicellular.

ii)

Criteria	Marks	Band
One disease caused by each of the six types of pathogens and presented in a table	3	5
One mark deducted for one incorrect disease or not presenting information in a table	2	4
Another mark deducted for another incorrect disease	1	3

Answer:

Pathogen	Disease
prion	Mad cow disease
virus	influenza
protozoan	malaria
macro parasite	head lice
bacterium	diphtheria
fungus	thrush

Q24. (4 Marks)

Criteria	Marks	Band
Beadle and Tatum's work with Neurospora, the conclusion they made, the theory they proposed and the modifications to the theory.	4	6
3 of above	3	5
2 of above	2	4
1 of above	1	3

Answer:

Beadle and Tatum exposed a large sample of spores of the bread mould *Neurospora* to X-rays in order to cause mutations. The mutated spore could not grow unless an amino acid, arginine was added to the normal culture media. Arginine needs several enzymes to be made and they isolated each of the strains of mould that was found not to produce one of the enzymes required for arginine synthesis.

Beadle and Tatum concluded that for each defective enzyme there was one gene that had been mutated by the irradiation. This led to the 'one gene-one enzyme theory'.

This later became modified to one gene-one protein and then one gene-one polypeptide because not all proteins are enzymes and many proteins are made up of more than one polypeptide i.e. there is one gene for each polypeptide in the chain of polypeptides that make up enzymes.

Q25.(5 Marks)

A)

Criteria	Marks	Band
Correct working showing genotypes of parents and 25% chance of producing a colourblind child	2	6
One of the above.	1	5

Answer:

Parents: $X^C X^c$ X $X^C Y$

Gametes X^C, X^c X^C, Y

F₁ $X^C X^C, X^C X^c, X^C Y, X^c Y$

Therefore, 25% chance of producing a colourblind child.

B)

Criteria	Marks	Band
Describe the organism Morgan studied, the experiment carried out, and the conclusion	3	6
Two of the above.	2	5
One of the above	1	4

Answer:

Morgan experimented with fruit flies.

He crossed red eyed females flies with white eyed males. The resulting offspring were all red eyed, and he assumed, red eye colour to be dominant to white. When he crossed two of the F₁ individuals with each other, there were no white eyed females.

He concluded that the gene for eye colour must be carried on the X chromosome. Males carry only one allele because the Y chromosome is smaller and carries less genetic information. When the male inherits a recessive, white eye allele on the X chromosome there cannot be an allele carried on the Y chromosome to mask the effect. The condition is sex linked or X-linked.

Q26. (4 Marks)

Criteria	Marks	Band
4 different aspects of meiosis discussed in terms of chromosomes and genes.	4	6
3 aspects discussed	3	5
2 aspects discussed	2	4
1 aspect discussed	1	3

Answer:

Inheritance of genes follows the behaviour of chromosomes because genes are located on chromosomes.

Chromosomes are double stranded because the chromosomes have replicated, genes are copied when the chromosomes are copied. If they are on the same chromosomes they are said to be linked.

In the first stage of meiosis, when homologous chromosomes pair, crossing over of chromosomes may occur and some genes change position during meiosis, and the linkage is broken. As homologous chromosomes segregate, allele pairs also segregate. In the second stage of meiosis, chromatids separate and the four cells (gametes) are formed with haploid number of chromosomes, gametes contain only one copy of a gene since they only receive one chromosome.

Q27. (7 Marks)

A)

Criteria	Marks	Band
Name of one genetic characteristic studied	1	4

Answer: eg. tongue rolling ability

B)

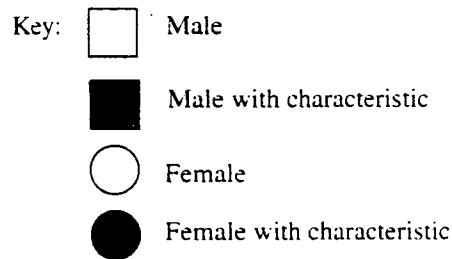
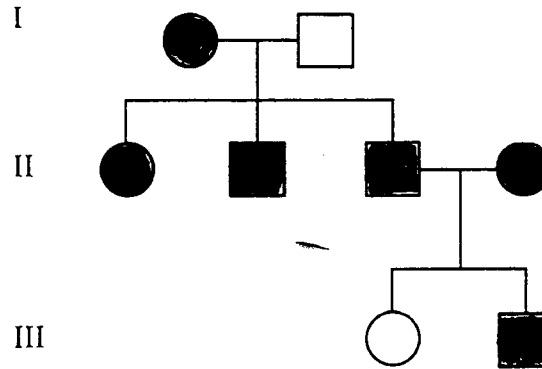
Criteria	Marks	Band
As large a sample within a family as possible must be examined for the trait and over a number of generations	2	4
One of the above	1	3

Answer: Tongue rolling ability was examined in as many family members as possible and over as many generations as possible. A family pedigree was drawn up, those

individuals with tongue rolling ability were shaded. It may be necessary to consult other family pedigrees to confirm if the characteristic is dominant or recessive.

C)

Criteria	Marks	Band
Correct construction of pedigree and inclusion of a key	2	6
One of the above	1	5



D)

Criteria	Marks	Band
A correct conclusion from the pedigree	1	5

Answer:

From this pedigree it can be concluded that tongue rolling ability is dominant.

E)

Criteria	Marks	Band
A correct use of a pedigree discussed	1	4

Answer:

Pedigrees are used by genetic counselors when advising prospective parents on the probability of having a child with a genetic disorder.

Q28 (25 marks)

A)

Criteria	Marks	Band
Correct genotypes of parents, types of gametes, possible offspring's genotypes and phenotypes	4	6
3 of above	3	5
2 of above	2	4
1 of above	1	3

Answer:

Parents: $rrI^{A^B} \times Rri$

Gametes: $rI^A, rI^B \times Ri, ri$

F1: $RrI^A i, rrI^A i, RrI^B i, rrI^B i$

Phenotypes: $Rh^+ A, Rh^- A, Rh^+ B, Rh^- B$

B)

Criteria	Marks	Band
Correctly distinguishes, referring to both terms	2	6
Refers to only one of the terms	1	5

Answer: Trisomy: a cell contains an extra chromosome eg three No. 21 = trisomy 21
 Polyploidy: a cell contains three or more sets of chromosomes. (eg. 3N, 4N)

C)

Criteria	Marks	Band
Correctly identifies DNA repair genes, and outlines one example of these genes and how it works.	3	6
2 of the above	2	5
1 of the above	1	4

Answer: DNA can repair itself by DNA repair genes such as the p53 gene. This gene can stop the cell cycle to allow for the repair of damaged DNA by other proteins. If it is faulty, uncontrolled cell division of damaged DNA can occur causing tumours. One example of how these genes operate involves the production of a number of enzymes, some enzymes remove the damaged bases, others insert the correct nucleotides and other enzymes join the break in the DNA strand.

D)

Criteria	Marks	Band
Correctly defines a transposon, a result of their operation, their affect on a species, and impact on the genome	4	6
3 of the above	3	5
2 of the above	2	4
1 of the above	1	3

Answer: Some segments of DNA move from one part of the genome to another, these segments are 'transposable'. * diagram

They can result in the attachment of new genes onto different chromosomes and can even be inserted into another gene causing a mutation.

The impact of transposable elements on the genome includes their ability to alter gene expression, affecting the evolution of species. Scientists believe they are involved in the ability of bacteria to rapidly evolve resistance to antibiotics.

E)

Criteria	Marks	Band
Identify a reason why the HGP could not be achieved by linkage maps, make a judgement of outcomes of linkage maps and the HGP, explain a method for identifying the position of a gene on a chromosome, identify how recombinant DNA is used in this method.	7-8	6
Identify a reason why the HGP could not be achieved by linkage maps, make a judgement of outcomes of linkage maps and the HGP, explain a method for identifying the position of a gene on a chromosome.	5-6	6
Identifies a reason why HGP could not be achieved by linkage maps and identifies a method for identifying the position of a gene on a chromosome, with limited explanation	3-4	5

Identifies a reason why HGP could not be achieved by linkage maps and identifies a method for identifying the position of a gene on a chromosome	1-2	5
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Answer: The human genome is made up of thousands of genes that do not express for a disease, linkage maps only provide information about known genes that cause inherited diseases. Studying family histories of a particular disorder would also be very time consuming, requiring DNA to study.

The Human Genome Project also deduced the DNA sequence of each gene and linkage maps would not provide this information. Some segments of DNA overlap and repeat themselves. Linkage maps are too simplistic.

Recombinant DNA technology is used to make probes for identifying genes on a chromosome. A probe is a specific sequence of DNA that is complementary to a gene. Once a probe is prepared, recombinant DNA technology is used to clone many copies of it and then it is tagged with a fluorescent dye. When the probe is added to a preparation of chromosomes in which the strands of DNA have been separated, the probes will hybridise or bond with the complementary DNA. If a fluorescent light is turned on, the tag glows brightly and so its position can be identified. This process is called FISH or Fluorescent in situ Hybridisation.

F)

Criteria	Marks	Band
Germline mutation distinguished from somatic mutation and the effect of each on the species.	4	5
3 of the above	3	4
2 of the above	2	3
1 of the above	1	2

Answer:

A germline mutation occurs in the gametes and can therefore be inherited. If it is a favourable mutation this can affect the evolution of that species through natural selection as those that have that favourable variation will be better adapted to their environment. An unfavourable mutation could adversely affect the survival of a species.

A somatic mutation occurs in the body cells and can therefore not be passed onto offspring although they can cause diseases such as cancer.