Section 1
75 Marks

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

Use the multiple choice answer sheet

1. Which of the following statements best describes Mendel's work on inheritance?

A. Some factors are carried on different chromosomes and some factors are carried on the same chromosome.

B. Some genetic characteristics are controlled by factors that are co-dominant

C. Genes on the X chromosome can be passed from mother to son

D. Characteristics are determined by pairs of factors that are inherited independently

2. If a red flowered snap dragon is crossed with a white flowered one, the progeny will all be pink flowered.
Which of the following is the most correct prediction of the ratios of offspring when a red snapdragon is crossed with a pink snapdragon?

A. 1 red : 1 pink

B. 1 pink: 3 white

C. 1 red : 2 pink: 1 white

D. 1 red : 1 pink : 2 white

3. In ferrets the brown coat colour is dominant over the white colour. A heterozygous brown female was crossed with a heterozygous brown male. What would be the probability of an offspring being homozygous?

(A) 25%

(B) 50%

(C) 75%

(D) 100%

4. What was the role of Sutton and Boveri in genetics?

(A) They showed chromosomes are made of DNA

(B) They showed that a full set of chromosomes is necessary for normal development

(C) They provided evidence that sex-linked genes deviate from the Mendelian pattern of inheritance

(D) They worked out the base pair rule

5. What is the function of cytotoxic T-lymphocytes?

(A) Kill and digest specific pathogen cells

(B) Produce antibodies against specific antigens

(C) Engulf and destroy pathogens

(D) Destroy the body cells which have become infected with a pathogen

6. Which of the following is the best explanation for the body's rejection of transplanted tissue?

(A) The antibodies on the transplant are different so that an immune response is triggered

(B) The transplanted tissue contains pathogens which trigger an immune response

(C) The immune response is triggered due to the trauma of the transplant process

(D) The antigens on the transplant trigger the immune response

7. Which of the following is part of the second line of defence adaptations that fights against invading organisms?

(A) Acid in the stomach

(B) Cilia in the respiratory system

(C) Macrophages in the lymphatic system

(D) Sterile urine in the urinogenital system

8. Which description below correctly identifies the characteristics of the genetic material found in some types of infective agents?

	Contains no nucleic acid, protein only	DNA or RNA in a protein coat	DNA in the cell cytoplasm	DNA in membrane bound nucleus
A	**Prion**	**Virus**	**Bacterium**	**Protozoan**
B	Virus	Prion	Bacterium	Protozoan
C	Prion	Virus	Protozoan	Bacterium
D	Virus	Prion	Protozoan	Bacterium

9. The emphasis of health programmes has changed over time, from being predominantly concerned with treating diseases, to prioritizing the prevention of the spread or incidence of diseases.

Which development in medical science has best led to the prevention of diseases?

(A) The use of chemotherapeutic drugs to treat cancers

(B) The determination by Pasteur that microorganisms caused decay of foods

(C) The widespread use of vaccines

(D) The discovery of penicillin

10. A group of students conducted an experiment that produced the results shown in the table. Students washed their hands and then touched nutrient agar dishes with their fingers. Some students acted as controls by not washing their hands.

	Unwashed hands	Hands washed with antibacterial soap	Hands washed with normal soap
Number of bacterial colonies grown on agar	58	21	24
Number of fungal colonies grown on agar	34	12	11

Which of the following is the most appropriate hypothesis for this experiment?

(A) Washing hands prevents disease

(B) Antibacterial soap kills microbes on hands

(C) Microbes are present on hands

(D) Antibacterial soap prevents the transmission of disease

11. What do B cells produce when they bind to an antigen and undergo cell division?

(A) a macrophage and a memory cell

(B) a memory cell and a killer T cell

(C) a plasma cell and a macrophage

(D) a plasma cell and a memory cell

12. Which of the following statements best describes enantiostasis?

A. A process of detecting change in the environment and responding to that change

B. The maintenance of stable conditions within the cells of an organism, despite fluctuations in the environment

C. The maintenance of functioning in organisms that live in highly variable environments

D. The speeding up of chemical reactions in cells by lowering the activation energy

13. After a long day in the sun a worker becomes dehydrated.

Which one of the following hormonal responses would best counteract this?

A. The secretion of ADH to increase the permeability of the collecting ducts

B. The suppression of ADH to decrease the permeability of the collecting ducts.

C. The secretion of aldosterone to boost salt movement into the nephron

D. The suppression of aldosterone to decrease salt movement into the nephron

14. The following equipment is set up in a laboratory for a first-hand investigation:

data logger, pH probe, beaker of distilled water and a drinking straw. What could the student be investigating with this equipment?

A. the effect of temperature on enzyme functioning

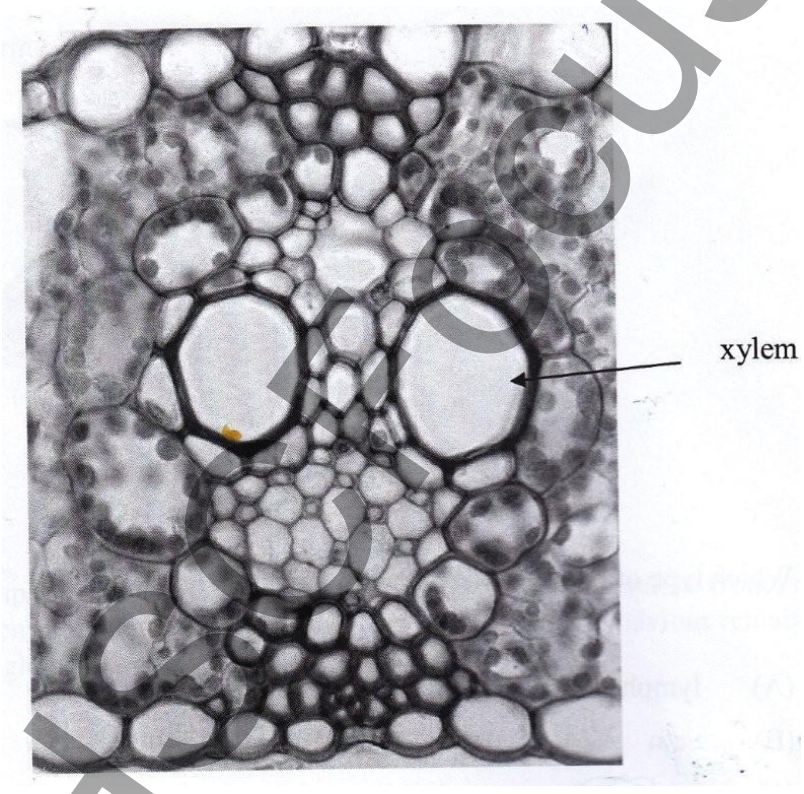
B. the effect of pH on enzyme functioning

C. the effect of carbon dioxide on the pH of water

D. the effect of substrate concentration on enzyme functioning

15. The photomicrograph below shows a cross section through a vascular bundle. The area of the photomicrograph is 1.00mm X 0.80 mm.

What is the diameter of the large xylem vessel indicated?



A. 200 µm

B. 20 µm

C.2 µm

D.0.2 µm

Part B- 60 marks

Attempt Questions 16- 28
Allow about 1 hour and 45 minutes for this section

Answer the questions in the spaces provided

Question 16 (3 marks)

Red Green colour blindness is a sex-linked recessive condition.

In a family a female grandchild is red green colourblind. She examines her parents and grandparents and only one of these six people is colourblind.

In the space below use a pedigree diagram to show all the above mentioned members of the family to explain how she inherited the condition.

Make sure you identify any carriers and the relative who is also colourblind.

Criteria	Marks
• Correct pedigree diagram and key including all 5 symbols • 3 carriers correctly identified • Colourblind relative correctly identified (father)	3
Two of the above	2
One of the above	1

Answer:
Pedigree showing grandparents, parents and child

The Father of the child is also colourblind.
There are 3 carriers- both Grandmothers and the Mother of the child
Key:

Question 17 (2 marks)

How can artificial insemination alter the genetic composition of a population?

Criteria	Marks
• Greater number of individuals with desirable characteristic • Genetic diversity of population decreased	2
One of the above	1

Artificial insemination is a simple technique which injects sperm, containing semen into the female's reproductive tract. One male can sire offspring from several females. It is used to produce many offspring with favourable characteristics eg disease resistant cattle. However, if farmers are consistently use the same sperm donors, the genetic diversity of the population will **decrease.** (In a changing environment the lack of diversity could endanger the survival of the species.)

Question 18 (6 marks)

Evaluate the importance of collaboration and communication in scientific research that eventually led to the construction of a model of DNA

Criteria	Marks
Description of issue- scientists, involved, those that built the model	1
Advantages of their approach	2
Disadvantages of their approach	2
Judgement- determine the value of collaboration and communication	1

Answer:
The four people who were instrumental in determining the structure of DNA worked at two different places. Rosalind Franklin and Maurice Wilkins were from King's College London and James Watson and Francis Crick were from Cambridge University.

Rosalind Franklin was a woman working in a field that was male dominated. This limited the amount of scientific discussion that could take place. Her work on X-ray diffraction showed that DNA had the characteristics of a helix. She wished to gather more evidence of this result, as she was a highly meticulous worker but Maurice Wilkins showed her results to Watson and Crick without her permission or knowledge. Wilkins and Franklins working relationship was very strained. Although they were experts in their fields- Wilkins in isolating high quality DNA and Franklin with her X-ray diffraction skills and ability to analyse the photos and collecting vast amounts of data. Unfortunately they did not discuss their findings with one another and communication was very poor.

This information from the photo shown by Wilkins was enough to encourage Watson and Crick to develop their model of the double helix for the structure of DNA. They used a more collaborative approach, discussing ideas, communicating well each other. Watson and Crick were heavily influenced by the findings of Erwin Chargaff in the 1940's – the amount of guanine is the same as the amount of cytosine and the amount of adenine is the same as the amount of thymine. and this suggested the pairing, A-T, C-G. they gathered large amounts of information on DNA and through effective communication with each other and others working in this field they eventually built a model which allowed them to visualise all their knowledge of the structure of DNA and possible mechanism for replication

The successful working style of Watson and Crick was therefore a major contributing factor that led to them being awarded the Nobel prize in physiology and medicine in 1962 for their work on the discovery of DNA.

Question 19 (5 marks)

The table shows a list of amino acids and the base sequences ona messenger RNA strand the code for them during protein synthesis.

Amino Acid	mRNA code
Tyrosine	UAU
Glycine	GGG
Alanine	GCG
Phenylalanine	UUU
Arginine	AGG

A section of DNA contains the base sequence:

ATATCCAAACGC-

For the DNA strand given, describe the steps by which this code could be used by ribosomes to make a polypeptide.

Criteria	Marks
• Correctly describes the transcription of the DNA triplets into the correct mRNA strand, • movement of mRNA into the cytoplasm and a ribosome, • the role of the anticodons on amino acid specific tRNA in translating the code into the correct amino acid sequence, • joining of the amino acids into a polypeptide • correct amino acids given	5
4 of the above	4
3 of the above	3

2 of the above	2
1 of the above	1

Answer
DNA unzips and the strands separate
Transcription of the gene occurs, the DNA acts as a template and the complementary single stranded mRNA molecule is formed , in this case ***UAUAGGUUUGCG***
The mRNA moves out of the nucleus and into the cytoplasm where it encounters ribosomes
The ribosome moves along the mRNA molecule and tRNA anticodons pair with the codons on the mRNA
The amino acids are linked by an enzyme to form a polypeptide chain. In this case the chain will be: ***Tyrosine Arginine Phenylalanine Alanine***
tRNA moves away from the mRNA to pick up another amino acid.

Question 20 (4 marks) **Marks**

The cloning of organisms has been assisted by advances in technology.

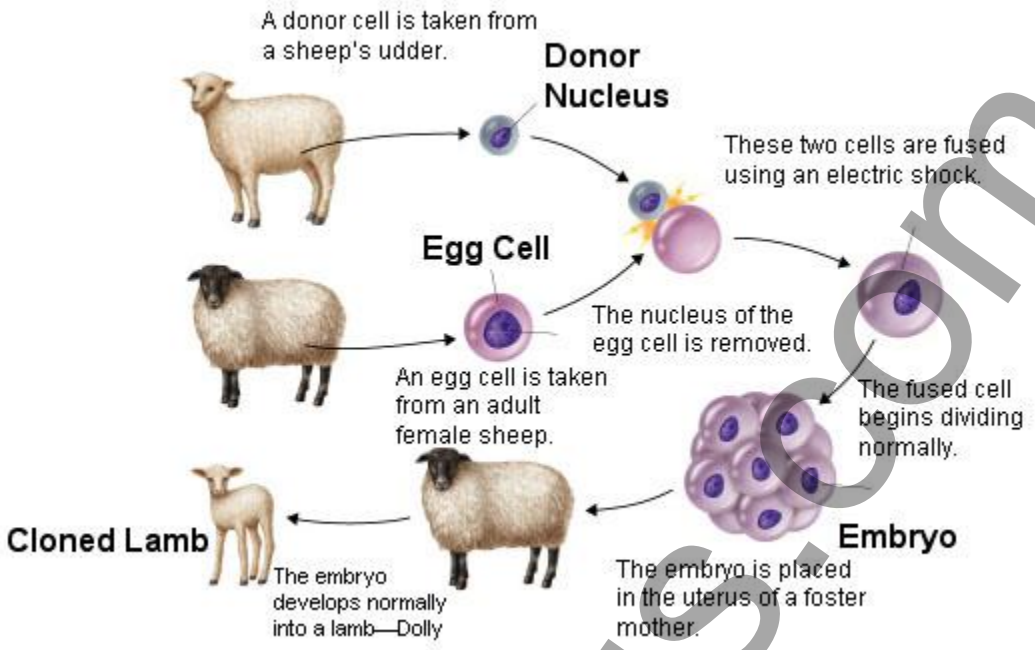
(a) Define the term clone.

A individual is made identical to the one that already exists DNA is identical

1

(b) Use a labelled diagram to outline the major processes used to clone an organism. Show clearly on your diagram which animals are clones. **3**

Answer:



The first sheep that donated the udder cell and the lamb are clones

Criteria	*Marks*
• Somatic cell nuclear transfer method requires an egg cell(removal of haploid nucleus) and • a donor cell (remove diploid nucleus), place diploid nucleus into egg cell. • Place egg cell with transplanted diploid nucleus into a surrogate mother for gestation, growth and development	*3*
Two of above	*2*
One of above	*1*

Question 21 (6 marks)

On 24th August 2007, a veterinarian reported to NSW Department of primary Industries (NSWDPI) that he had observed sick horses at Centennial Park in Sydney. The report followed an outbreak of equine influenza (EI) in Japan and the import of stallions from Japan. Laboratory testing revealed the horses at Centennial Park were infected with EI.

The outbreak that eventuated was the most serious emergency animal disease Australia has experienced in recent history. At its peak, 47,000 horses were infected in NSW on 5943 properties, and horse owners and industry workers were facing dark times with major impacts on their livelihood and lifestyle. Humans do not get infected with EI but they can physically carry the virus on their skin, hair, clothing and shoes.
The campaign led by NSWDPI to eradicate the disease was the largest of its type ever undertaken in Australia, using the latest methods for disease control.
The disease was eradicated within six months well ahead of predictions and by July 2008 horse industry operations had returned to normal

With reference to the above article, discuss strategies for managing this disease and how these could have resulted in such an effective control of the disease.

Answer:

- ***Quarantine restrictions*** *to keep new infections close to already infected properties and designating these as restricted areas helped reduce the spread*
- ***Locking down on all horse movements****- this restricted the spread of the disease to a defined area*
- ***Tracing the spread*** *of the disease by veterinary investigatorsto provide horse owners with the latest information concerning the risk of infection in their area*
- *When the lockdown was eased in areas less at risk,* ***all horse movement was carefully monitored****- notification of all horse movements was mandatory to reduce the spread of the disease*
- ***Vaccination*** *of horses- buffer zones around the infected areas were made more effective and held within certain areas, and to reduce the number of newly infected horses*
- ***Restrictions placed on people and equipment*** *from infected areas transferring the virus to new areas*
- ***Laboratory tests*** *enabled accurate detection of infected animals using blood tests so that infected horses could be quarantined quickly to prevent further spread*

- ***Information provided*** *in papers, radios, TV, internet and phone hotlines to provide particularly up to date information on the progress of the disease and the restrictions that were in place reduce the risk of infection*

Criteria	Marks
At least three of the above strategies, each discussed and with an explanation as to how this method could control the disease	6
Three strategies, two explained	5
Two of the above strategies, both explained	4
Two strategy and one explanation	3
One stategy with explanation	2
One strategy	1

Question 22 (2 marks)

Describe two mechanisms that allow the interaction between B and T lymphocytes.

Answer:
Helper T cells release chemicals that activate the cloning of cytotoxic T cells and B cells that are specific for a particular antigen.
On the surface of cells there are MHC molecules that allow the recognition of cells from the body- these stop the body from attacking its own B and T cells so they can interact successfully

Criteria	Marks
Two mechanisms described	2
One mechanism described	1

Question 23 (4 marks)

Describe how gene expression is linked with maintenance and repair of body tissues.

Answer:

A gene is expressed when it is switched on and the DNA code is used to produce a polypeptide that may ultimately control the structure of function of the cell in some way. If an error occurs DNA can be repaired so that normal functioning and growth can occur. Some genes can stop the cell cycle while DNA repair genes remove damaged DNA replace it with the correct sequence. The p53 gene is capable of producing proteins that can stop the cell cycle (during G1) to allow for repair of damaged DNA by other proteins produced by DNA repair genes.
Proto-oncogenes can then stimulate cell division and tumour suppressor genes can slow down or stop cell division. In a healthy cell the balance in these genes controls the cell cycle which allow for growth and replacement of damaged cells. If damage occurs to these types of genes then cancer can form due to uncontrolled cell division.

Criteria	Marks
• Description of gene expression • Two examples of genes that can regulate the cell cycle • The need for correct gene expression of these genes to ensure maintenance and repair	4
As above but with mention of one gene	3
As above but no specific mention of genes involved	2
General description of gene expression only	1

Question 24 (8 marks) **Marks**

A life-saving malaria vaccine could be available in just a few short years.

In the case of malaria, this could mean the difference between life and death for millions of children in Africa.

(a) Describe how two other methods have been used to assist in the prevention of malaria? **2**

Answer:

- *The destruction of the vector- the Anopheles mosquito or the prevention of it breeding-by means of insecticides, draining stagnant water, the introduction of fish to eat the larvae of the mosquito*
- *The protection of the host by the preventative use of drugs(prophylatics), and the use of protective clothing-long sleeves and trousers ,insect repellents and mosquito nets treated with insecticide*

Criteria	Marks
Two methods of prevention describing how they prevent malaria	2
One method of prevention describing how it prevents malaria	1

(b) Outline the way in which vaccination could prevent malaria.

Answer:
Vaccination is a way of giving a person the "experience" of having had an infection without actually having it, so that the body responds to the "experience" by causing the immune response and producing the appropriate memory cells.

- *The way in which the "experience" is given depends on the pathogen. Sometimes a much less harmful pathogen is given, sometimes the pathogen is weakened and made harmless (attenuated), sometimes a dead pathogen is given Many pathogenic bacteria are harmful to the body because of the toxins they produce. Sometimes the toxins are modified to produce the vaccine.*
- *Whatever the source of the vaccine, the effect is the same. It introduces antigens into the body so that B cells are activated to produce large amounts of antibody and B cells that are stored in the lymph system are ready for a future attack by the particular pathogen. Booster injections increase the number of memory cells.*
- *The vaccine does not produce the symptoms of the disease and if the body is exposed to this antigen in future a more rapid response, producing a greater quantity of antibodies, the antigen will be destroyed before symptoms of the disease are experienced.*

Criteria	*Marks*
• *Outline the content of the vaccine* • *Outline how the immune response is triggered* • *Outline what happens if the same antigen were to re-enter in the future*	*3*
Two of the above	*2*
One of the above	*1*

(Question 24 continued)

(c) Evaluate the effectiveness of another vaccination program for one named disease. **3**

*Answer: **Smallpox** has killed more people than any other infectious disease and was responsible for one tenth of all deaths in the 19th century and more than 300 million deaths in the 20th century. In 1967 there were 33 countries in the world where smallpox was a major problem. Although a vaccine was developed by Jenner in 1796 it was not widely used. The WHO carried out a worldwide immunisation program in 1968 and by 1979 WHO declared that smallpox had been eliminated from the world population.*
Therefore this vaccination programme has been extremely effective in eliminating this once common disease, reducing to zero the occurrence and spread of this disease.

Marks	**Criteria**
• Description before vaccination, of extent named disease • Description after vaccination program • Judgement of effectiveness	3
Two of the above	2
One of the above	1

Question 25 (5 marks) **Marks**

(a) Homeostasis is the maintenance of a stable internal environment.

(a) Using and example of homeostasis, complete the table below **3**

Example of homeostasis: *Answer: Stable internal conditions are important for optimal metabolic efficiency conditions. eg* *Maintenance of a constant body temperature of 37ºC.*	
One way in which changes from the stable state are detected	**One way in which changes from the stable state are counteracted**

Thermoreceptors in the skin and Hypothalamus in the brain detects a change in temperature eg. a rise in blood temperature and converts this to a message in the form of nerve impulses, which travel along nerves to the central nervous system (CNS)	*Muscle or glands receive impulses from the CNS which instruct effectors to bring about a response eg sweat glands to produce sweat to cool the body; eg the thyroid gland to produce less thyroid stimulating hormone so metabolism is decreased and less heat is produced; eg the muscles in blood vessels vasodilate so more heat is lost*

(b) Explain why homeostasis is important. **2**

Answer:
Optimum conditions such as for pH and temperature are needed for the proper functioning of enzymes an optimal metabolic efficiency. If conditions are not optimum then enzyme activity will be reduced and enzymes can even be denatured at extremes of temperature and pH, death can result.

(a)Table contains: • an example of homeostasis, • how a specific change is detected, • how the specific change is counteracted. (b) general reference to: • enzymes and • their decreased efficiency if homeostasis is not achieved	3 2
4 of the above	4
3 of the above	3
Two of the above	2
One of the above	1

Question 26 (5 marks)

Construct a table to compare renal dialysis with the function of the kidney.

Answer:

Feature	*Kidney*	*Renal dialysis*
Structure	*Consists of about 1 million nephrons which filter the blood*	*Haemodialysis occurs in a hospital, the patient is attached via a tube to a machine that circulates blood through semipermeable filters that removes toxins from the*

		blood
Main function	*Filters blood to remove urea from the blood*	*Filters blood to remove urea from the blood*
Other functions	*Maintains body's salt balance, releases various hormones*	*Concentrations of desired solutes can be adjusted by altering the composition of the dialysis fluid, dialysis cannot replace hormones*
How often it occurs	*Each day the 2 kidneys excrete 1.5-2.5 litres of urine*	*3-4 hours in hospital, two or three times a week*
Reabsorption	*Reabsorbs required materials*	*No reabsorption*
Temperature	*At normal body temperature (37ºC)*	*Water bath maintains dialysis fluid at 37ºC*

Criteria	Marks
• Clear presentation of table • 4 different features that are similar or different	1 4
Clear table and 3 correct features	4
Clear table and 2 correct features	3
Clear table and 1 correct features	2
Clear presentation of table	1

Question 27 (4 marks) **Marks**

Identify the form in which each of the substances below is carried in the blood.

a) nitrogen waste- *in the form of urea, uric acid and creatinine, dissolved in* plasma

b) oxygen- *attached to haemoglobin in red blood cells as oxyhaemoglobin*

c) lipids-*enclosed in a package of protein to form a structure called chylomicron and transported in blood and lymph*

d) salts- *as ions eg chloride ions transported dissolved in plasma*

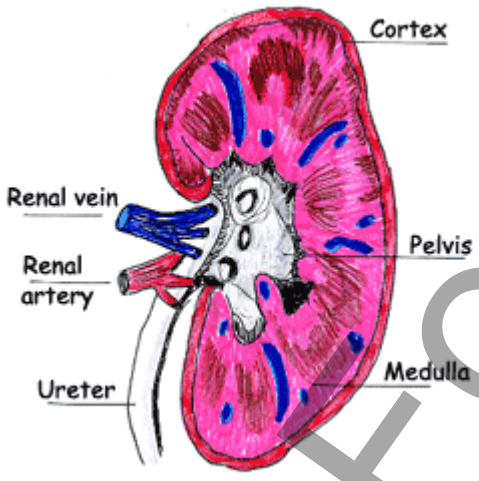
Criteria	Marks

Correctly identifies the form in which nitrogen waste, oxygen, lipids, salts are carried in the blood	4
Correctly identifies three of the above	3
Correctly identifies two of the above	2
Correctly identifies one of the above	1

Question 28 (6 marks)

(a) Draw a diagram of a mammalian kidney and clearly label the regions that are necessary for the excretion of waste products. **4**

Answer:



Criteria	Marks
Correct shape of the kidney and Labels in correct position for cortex, medulla, pelvis, ureter, renal vein and renal artery	4
Correct shape and correct position for 4 or 5 of above labels	3
Correct shape and correct position for 2 or 3 of the above labels	2
Correct shape and correct position for one of the above labels	1

(b) Small mammals living in the desert produce extremely concentrated urine. Explain how this may be related to the structure of their glomeruli.

2

Answer:
Relatively long tubules(loop of Henle) to allow a large surface are over which reabsorption of water back into the blood can take place.

Criteria	Marks
Correct structural difference and reason for this difference	2
Correct Structural difference 0r reason for the difference	1

Question 29 - Genetice: The Code Broken (25) **Marks**

Answer the question in a writing booklet.

(a) Distinguish between mutations of chromosomes involving rearrangements and chromosome number changes using an example of each. **4**

Answer:

- *Both are chromosomal mutations and may involve large regions of a chromosome or a whole chromosome, in the case of number changes* ***Chromosomal number changes*** *occur during meiosis as a result of homologous pairs of chromosomes not separating during the first division. This is called non-disjunction and results in some gametes with extra chromosomes and others with less than the normal number. An example of this in humans is Down syndrome. During meiosis, the two number 21 chromosomes (usually in the mother) do not separate and the resulting ovum contains two number 21 chromosomes instead of just one, with a total of 24 instead of the normal haploid number of 23. When this ovum is fertilized by a normal haploid sperm with one number 21 chromosome (total 23), the resulting zygote is a* ***trisomy*** *and will have three number 21 chromosomes (total of 47 instead of the normal diploid number of 46). Down syndrome is also called trisomy-21 as there are three number 21 homologous chromosomes.*
- ***Chromosome rearrangements*** *do not result in a number change however several genes may be affected. There are several ways in which the genes can be rearranged eg deletion - where part of a chromosome breaks off and genes are effectively lost from the chromosome eg. Cri-du-Chat syndrome (a deletion occurs in a chromosome from pair 5);*

Criteria	Marks
• Indicate a difference between a chromosomal rearrangement and a chromosome number change, • describe a specific named example of each.	2 2
Any three of the above	3
Any two of the above	2

Any one of the above	1

(b) What is a gene homologue? Describe evidence which suggests the presence of ancestral vertebrate gene homologues in lower animal classes. **3**

Answer:

- *Genes which have similar structures and functions in different organisms are said to be homologous genes or homologues.*
- *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. A mammal homologue gene can regulate the corresponding gene in insects such as fruit flies.*

OR

- *Homologues, homeotic or Hox genes are found in most or all groups of multicellular animals and show similar DNA sequences suggesting that these genes evolved in a common ancestor. These genes, being similar in both structure and function, are expressed in similar sequences on chromosomes.*
- *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*

Criteria	*marks*
• *Description of a gene homologue* • *An example of a gene homologue* • *Evidence of this example in vertebrates and invertebrates.*	*3*
Two of the above	*2*
One of the above	*1*

(c) A man who has blood type A+ and his wife who has blood type B- have a child who is O-.
Identify the genotypes of both parents and child assuming the genes for ABO and the Rh factor are not linked. Show working to support your answer **4**

Answer:

Alleles fro Rh:R= Rh positive, r= Rh negative ,alleles for ABO: I^A= A, I^B=B, i=O

Father: I^Ai Rr can produce a gamete: ir
Mother: I^Birr can also produce a gamete: ir
Child: iirr

Criteria	marks
• Correct genotype for father • Correct genotype for mother • Correct genotype for child • Working to support answer	4
Three of above correct	3
Two of above correct	2
One of above correct	1

(d) Compare the processes of selective breeding and gene cloning using an example of each. **6**

Answer:
Selective breeding is the breeding of plants and animals with desirable characteristics to produce offspring with preferred characteristics. For example ***,selective breeding*** *of* ***wheat.*** *Farrer in the 1870's crossed Indian wheat which was drought tolerant and resistant to some diseases with Canadian Fife wheat which matured late and had the best milling and baking qualities. Some of the plants produced had the advantages of both parents*
Gene cloning *involves the production of many identical genes. eg for producing useful proteins such as* ***human insulin***
Human insulin, used by diabetics to control blood sugar levels, is now produced by the cloning of recombinant DNA.
This process occurs by using special cutting enzymes, known as restriction enzymes, to cut out the gene for making insulin from a human chromosome. The enzymes are also used to cut open a plasmid in a bacterial cell leaving "sticky ends". A plasmid is a circular piece of DNA within the bacterium. The sequence of bases in the open space in the plasmid matches the ends of the piece of human DNA. The human DNA is then inserted into the plasmid. The plasmid (now genetically engineered) is placed back into a bacterium and is reproduced every time the bacterium reproduces asexually.
In this way, the human gene has been cloned. When given all of the required nutrients, these bacteria will produce human insulin according to the human genes they contain. (Another method for gene cloning is PCR-polymerase chain reaction.)

Selective breeding and gene cloning both cause changes to the genetic nature of a species. However, the extent of the change is generally limited to the total available gene pool of the species for selective breeding. Thus it alters the combinations and frequency of genes but does not introduce new genes to the species. Gene cloning introduces a new gene sometimes from a different species.

In selective breeding, organisms with desirable characteristics are chosen and bred. However it is an imprecise strategy as the individual gene or characteristic cannot be selected. Gene cloning is a more precise technology as the gene to be cloned is selected and inserted into the genome of the organism.
Intensive selection can narrow genetic variability and this can make plants more vulnerable to attack by diseases and pests. eg if one variety of wheat is grown at the expense of all others. This could also happen when gene cloning is used to produce a transgenic species eg Bt cotton

Criteria	*Marks*
• *Describe the process of selective breeding* • *Describe an example of selective breeding* • *Describe the process of gene cloning* • *Describe an example of gene cloning* • *One similarity of each process* • *One difference of each process*	*6*
Any five of the above	*5*
Any four of the above	*4*
Any three of the above	*3*
Any two of the above	*2*
Any one of the above	*1*

(e) In sweet peas purple flowers (P) is dominant to red flowers (p);
long pollen (L) is dominant to round pollen (r).
When heterozygous individuals are crossed with homozygous recessive individuals the following number and types of plants were produced:

496 purple flowers, round pollen
504 red flowers, long pollen

Explain showing working, if the genes for these traits are linked or on different chromosomes. **4**

Answer:
If the genes are on different chromosomes then the following off spring could be produced:

P: PpLl X ppll

Gametes: Pl, Pl, pL, pl X pl
F_1 : PpLl , Ppll, ppLl, ppll
Purple long: purple round: red long: red round = 1:1:1:1

If the genes are linked P linked with l and p linked with L in one parent then the following offspring could be produced:

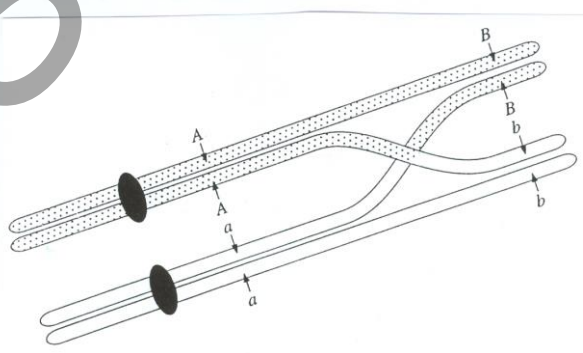
P; Pl/pL X pl/pl
Gametes: Pl, pL X pl
F_1: Pl/pl ,pL/pl

Purple round :red long = 1:1
The offspring that are produced are in the ratio 496:501 which is approximately 1:1 purple round :red long

Therefore the genes are linked.

Criteria	Marks
• Correct working for not linked • Correct ratio for not linked • Correct working for linked • Correct ratio and conclusion for linkage	4
Three of the above	3
Two of the above	2
One of the above	1

(f)



The diagram above shows chromosomes during cell division. **4**
(i)What is the name of the process occurring in this diagram?

Answer: Crossing Over
(ii)What is the name of the type of cell division in which it occurs?

Answer: meiosis
(iii) How can this process assist in chromosome mapping?
Answer:

A chromosome map shows the relative positions of genes on a chromosome. Alleles are genes situated on corresponding loci (positions) on homologous chromosomes. Crossing over results in the exact swapping of alleles from one of the chromosome pairs to another.
The greater the percentage of recombination and the more recombinant types produced in the offspring, the larger the distance that the genes are apart.

• *Correct process* • *Correct type of cell division* • *Correctly describes the rate of crossing or the number of recombinant types is dependent on the distance apart the genes are located on the chromosome* • *Correctly identifies the relationship- the greater the % of recombination, the larger the distance that the genes are apart*	*4*
Three of the above	*3*
Two of the above	*2*
One of the above	*1*

END OF TEST