Heredity

Chapter 1

- continuity of life requires the replication of genetic material and its transfer to the next generation through processes, including binary fission, mitosis, meiosis and fertilisation
- DNA is a helical double-stranded molecule that occurs bound to proteins in chromosomes in the nucleus, and as unbound circular DNA in the cytosol of prokaryotes, and in the mitochondria and chloroplasts of eukaryotic cells
- the structural properties of the DNA molecule, including nucleotide composition and pairing and the hydrogen bonds between strands of DNA, allow for replication
- the genetic code is a base triplet code; genes include 'coding' and 'non-coding' DNA, and many genes contain information for protein production
- protein synthesis involves transcription of a gene into messenger RNA in the nucleus, and translation into an amino acid sequence at the ribosome
- proteins, including enzymes and structural proteins, are essential to cell structure and functioning
- the phenotypic expression of genes depends on the interaction of genes and the environment
- mutations in genes and chromosomes can result from errors in DNA replication or cell division, or from damage by physical or chemical factors in the environment
- variations in the genotype of offspring arise as a result of the processes of meiosis, including crossing over and random assortment of chromosomes, and fertilisation, as well as a result of mutations
- frequencies of genotypes and phenotypes of offspring are determined by patterns of inheritance, including dominance, autosomal and sex-linked alleles, multiple alleles and polygenes
- DNA sequencing enables mapping of species genomes; DNA profiling identifies the unique genetic makeup of individuals
- recombinant DNA technology and DNA identification technologies are applied in agriculture and environmental conservation

MULTIPLE-CHOICE QUESTIONS

1. *(2012:01)*

If 20% of the nucleotides in a DNA fragment contain cytosine, what percentage will be thymine?

(a) 20

(b) 30

(c) 40

(d) 50

2.. *(2013:16)*

Which of the following occurs during protein synthesis?

(a) RNA molecules are converted to DNA molecules.

(b) Ligase unwinds DNA molecules.

(c) Restriction enzymes cut DNA molecules.

(d) RNA polymerase binds to DNA molecules.

3. *(2013:18)*

In gel electrophoresis

(a) positively charged DNA fragments move toward the negatively charged electrode.

(b) large DNA fragments move more rapidly than small DNA fragments because they have a greater electrical charge.

(c) the gel is porous and acts like a sieve, allowing some fragments to pass through the pores more easily than others.

(d) the DNA fragments are mixed evenly with the gel material before it solidifies.

4. *(2013:22)*

Which of the following techniques can be used to study the activity of many genes at the same time?

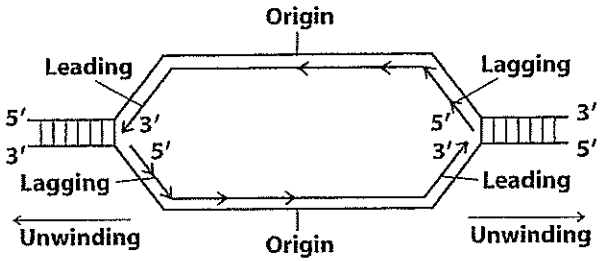
(a) gel electrophoresis

(b) polymerase chain reaction

(c) gene cloning

(d) DNA microarrays

The next question refers to the diagram below, which shows a cell process.



5. *(2014:01)*

This process is

(a) crossing over.

(b) DNA replication.

(c) transcription.

(d) meiosis.

6. *(2014:04)*

A eukaryotic cell will have more

(a) chromosomes than genes.

(b) chromosomes than alleles.

(c) alleles than genes.

(d) genes than alleles.

7. *(2014:11)*

Translation occurs on or in

(a) golgi vesicles.

(b) nuclei.

(c) lysosomes.

(d) ribosomes.

8.. *(2014:17)*

Which of the following processes describes the exchanges of alleles between homologous chromosomes?

(a) mutation

(b) independent assortment

(c) crossing over

(d) random mating

9. *(2014:22)*

The sequence of bases in a strand of DNA is ATCGAGC. The sequence of bases in a mRNA molecule synthesised from this strand will be

(a) ATCGAGC.

(b) TAGCTCG.

(c) UAGCUCG.

(d) TUCGAGC.

10. *(2015:10)*

In gene cloning, the main purpose of plasmids is to

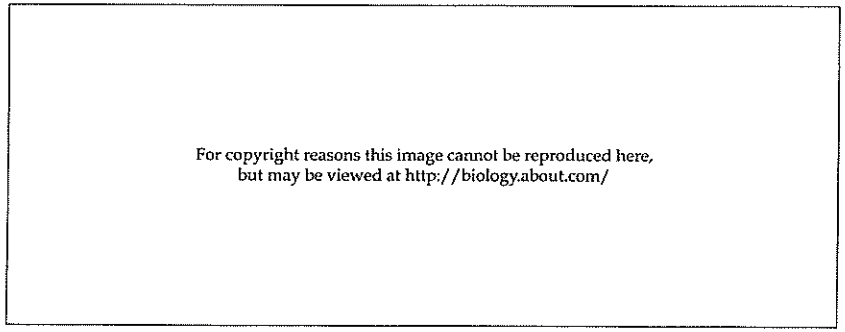
(a) identify the gene for cloning.

(b) extract the desired gene from a donor organism.

(c) produce many copies of the desired gene.

(d) introduce the desired gene into a recipient organism.

The next three questions relate to the diagram below, which shows a cell process.



11. *(2015:22)*

The process shown in the diagram is

(a) transcription.

(b) translation.

(c) DNA repair.

(d) DNA replication.

12. *(2015:23)*

The feature labelled X is a molecule of

(a) protein.

(b) DNA.

(c) tRNA.

(d) mRNA.

13. *(2015:24)*

The function of the feature labelled Y is to

(a) carry the genetic code from the DNA to the site of protein synthesis.

(b) encode the sequence of amino acids in a protein chain.

(c) transfer amino acids to the growing peptide chain during protein synthesis.

(d) correct errors in the sequence of amino acids in a protein chain.

14. *(2016:03)*

X-radiation (X-rays) is an agent that

(a) repairs DNA and decreases the mutation rate.

(b) damages DNA and decreases the mutation rate.

(c) repairs DNA and increases the mutation rate.

(d) damages DNA and increases the mutation rate.

15. *(2016:04)*

If 27% of the nucleotides in a DNA molecule contain guanine, what percentage will contain thymine?

(a) 23

(b) 27

(c) 46

(d) 54

The next question relates to the table below, which shows the mRNA codons for four amino acids.

Amino acid	mRNA codon
Histidine	CAU
Arginine	CGU
Methionine	AUG
Alanine	GCA

16. *(2016:17)*

On the basis of the data in the table, tRNA with the anti-codon GCA will carry

(a) histidine.

(b) arginine.

(c) methionine.

(d) alanine.

17. *(2017:01)*

DNA replication is described as

(a) conservative, because each new double helix consists of one parental and one newly-synthesised DNA strand.

(b) conservative, because each new double helix consists of two newly-synthesised DNA strands.

(c) semi-conservative, because each new double helix consists of one parental and one newly-synthesised strand.

(d) semi-conservative, because each new double helix consists of two newly-synthesised DNA strands.

18. *(2017:04)*

Bacterial cells reproduce by

(a) binary fission only.

(b) meiosis only.

(c) binary fission and mitosis.

(d) mitosis and meiosis.

19. *(2017:07)*

The number of tRNA molecules needed to synthesise the first 24 amino acids of a polypeptide chain is

(a) 8.

(b) 24.

(c) 25.

(d) 72.

20. *(2017:08)*

The approximate number of amino acids that could be coded for by a (mature) mRNA molecule comprising 1500 nucleotides is

(a) 150.

(b) 300.

(c) 500.

(d) 750.

21. *(2017:09)*

In the genetic code, other than for stop codons,

(a) each codon codes for only one amino acid but most amino acids are coded for by more than one codon.

(b) each codon codes for only one amino acid and each amino acid is coded for by only one codon.

(c) most codons code for more than one amino acid but each amino acid is coded for by only one codon.

(d) most codons code for more than one amino acid and most amino acids are coded for by more than one codon.

22. *(2017:11)*

In watermelons, fruit bitterness is determined by two alleles at a gene, where an allele for bitter fruit is dominant over an allele for sweet fruit. A plant that is heterozygous for these two alleles is crossed with a plant with sweet fruit. The expected fruit phenotypes in the progeny of these plants is

(a) all bitter fruit.

(b) all sweet fruit.

(c) 50% bitter fruit and 50% sweet fruit.

(d) 75% bitter fruit and 25% sweet fruit.

23. *(2017:13)*

In DNA replication, the enzyme DNA polymerase

(a) unwinds the DNA double helix.

(b) seals short stretches of nucleotides.

(c) adds nucleotides to a DNA strand.

(d) adds RNA primers to a DNA strand.

24. *(2017:14)*

A cell in the root tip of a bean plant has a total of 12 chromosomes. A mitotic division of this cell will produce

(a) two daughter cells, each with 12 chromosomes.

(b) two daughter cells, each with 6 chromosomes.

(c) four daughter cells, each with 12 chromosomes.

(d) four daughter cells, each with 6 chromosomes.

25. *(2017:18)*

The diploid number of chromosomes in the chimpanzee is 48. A chimpanzee with stunted growth and other abnormalities was found to have 49 chromosomes. The **most** likely source of the extra chromosome in this chimpanzee is

(a) a viral infection in the chimpanzee.

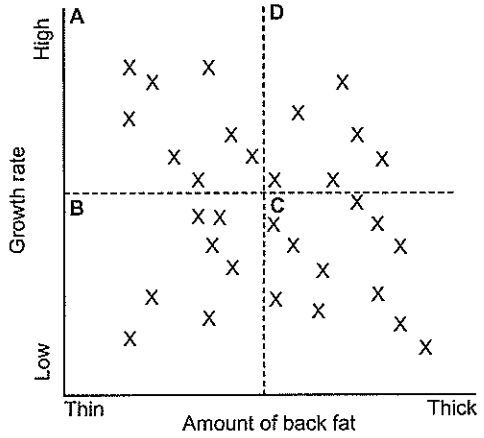
(b) a viral infection in one of the parents of the chimpanzee.

(c) an error in meiosis in the chimpanzee.

(d) an error in meiosis in one of the parents of the chimpanzee.

The next question relates to the diagram below.

A biologist measured the growth rate and the thickness of back fat in a group of pigs. The results are shown in the diagram, where each 'X' represents one pig. The biologist divided the pigs into four groups (A, B, C and D) according to their growth rate and thickness of back fat, as shown in the diagram.



26. *(2017:19)*

What type of trait is growth rate in this group of pigs?

(a) autosomal

(b) recessive

(c) dominant

(d) polygenic

27. *(2017:26)*

Some antibiotics kill bacteria by blocking ribosome function. This directly stops the bacteria from producing

(a) DNA.

(b) mRNA.

(c) tRNA.

(d) proteins.

28. *(2017:27)*

Crossing over is the

(a) exchange of alleles between homologous chromosomes.

(b) exchange of alleles between non-homologous chromosomes.

(c) segregation of homologous chromosomes to different poles.

(d) segregation of non-homologous chromosomes to different poles.

29. *(2017:28)*

Like humans, cattle have an XY system of sex determination. In cattle, a disease called AED is caused by a recessive allele at a gene on the X chromosome. Two cattle that do not have AED disease produce a male offspring with AED disease and a female without AED disease. What is the probability that the female offspring is a carrier of AED, i.e. has one copy of the AED allele?

(a) 100%

(b) 50%

(c) 25%

(d) 0%

SHORT ANSWER QUESTIONS

30. **[4 marks]** *(2012:34)*

(c) Humans are now using recombinant DNA technology to modify the characteristics of plants and animals.

Outline how recombinant DNA technology can be used to increase drought resistance in rice.

31. **[11 marks]** *(2013:31)*

(a) Describe the relationship between DNA, genes and chromosomes. [3]

CONTINUED NEXT PAGE

Parts (b) and (c) refer to the table below. It provides data on the number of chromosomes, amount of DNA and amount of time taken for meiosis to occur in germ cells of selected plant and animal species.

Species	Number of chromosomes	Amount of DNA (picograms)	Duration of meiosis (days)
Plants			
Triticum aestivum (wheat)	42	54	1
Secale cereale (rye)	14	29	2
Allium cepa (onion)	16	54	4
Lilium longiflorum (lily)	24	106	8
Trillium erectum (wake-robin)	10	120	11
Animals			
Drosophila melanogaster (fly)	8	0.085	4
Locusta migratoria (locust)	24	13	8
Triturus viridescens (amphibian)	24	49	12
Mus musculus (mouse)	40	5	13
Homo sapiens (human)	46	6	24

(b) (i) The data in the table indicate that germ cells with larger chromosome numbers do not necessarily contain more DNA. Provide a possible reason for this. [1]

(ii) What do the data in the table suggest about the relationship between the amount of DNA in a germ cell and the duration of meiosis in the plant species? [2]

(c) (i) The data in the table suggest that the duration of meiosis might be slower in animals than plants. What aspects of the data suggest this? Quote data from the table to support your answer. [3]

(ii) Despite your answer above, the data in the table do not allow for reliable conclusions to be drawn about the relative duration of meiosis in plant and animal species. Give two possible reasons for this. [2]

32. [4 marks] *(2013:34)*

(c) Many proteins are produced in the ribosomes within the cytoplasm of a cell.

How does messenger RNA determine the sequence of amino acids during protein synthesis?

33. [4 marks] *(2013:35)*

Dry land salinity is a major problem in Australian agricultural areas and especially in south-western Australia.

(e) A plant species was found that was able to grow in soils with a salt concentration well in excess of 100 g/L. The species is not suitable for revegetation of saline agricultural areas because it is poisonous to farm animals.

Summarise how recombinant DNA techniques could be used to take advantage of this plant's salt resistance in other, more suitable species.

34. [13 marks] *(2015:34)*

(a) Indicate whether each of the following statements about DNA replication is true or false by circling the correct answer. Give a reason for your answer.

(i) The base sequence of a newly-synthesised strand of DNA is identical to that of the template strand from which it was synthesised. [2]

True False

Reason:

(ii) DNA replication is called 'semi-conservative' because the wrong base is sometimes added to the newly-synthesised strand of DNA. [2]

True False

Reason:

(b) Polymerase Chain Reaction (PCR) is an important method in biotechnology.

(i) What is PCR used to do? [2]

(ii) State **three** reagents (ingredients) that are required for PCR. [3]

One:

Two:

Three:

(c) (i) Distinguish between a gene and an allele. [2]

(ii) Distinguish between a dominant allele and a recessive allele. [2]

35. [16 marks] *(2016:31)*

(b) Describe **two** differences between DNA and RNA molecules. [4]

One: _____

Two: _____

In the maize plant, the texture of the seed is either smooth or wrinkled. Seed texture is determined by the alleles at a single gene. A plant with wrinkled seeds was crossed with a plant with smooth seeds (Parent generation). The parent plant with smooth seeds was a homozygote at the seed texture gene. All of the offspring of the cross had smooth seeds (F_1 generation). Individuals in the F_1 generation were crossed with each other to produce a second generation (F_2 generation).

(c) On the basis of the above information, what seed phenotypes would be present in the F_2 generation and in what proportions would they occur? Show your workings. Use S_1 to indicate the allele that produces smooth seed and S_2 to indicate the allele that produces wrinkled seed. [5]

(d) The vinegar fly, *Drosophila melanogaster*, has an XY system of sex determination like humans. White eye, where the eyes lack pigment, is determined by a gene on the X chromosome. The allele that causes white eye is recessive to the allele for normal (pigmented) eyes. List all possible genotypes for the white eye gene for the following flies. Use 'w' to designate the white eye allele and '+' to indicate the allele that produces normal eyes. [4]

1. A male with white eyes: _____
2. A male with normal eyes: _____
3. A female with white eyes: _____
4. A female with normal eyes: _____

(e) Explain what a polygenic trait is. Give a specific example. [3]

36. [8 marks] *(2016:35)*

(b) List the main steps involved in producing a DNA profile for an organism. [4]

CONTINUED NEXT PAGE

(d) State the role that the following factors play in gene cloning. [4]

Restriction enzyme: _____

_____

_____

Ligase: _____

_____

_____

Plasmid: _____

_____

_____

Vector: _____

_____

_____

37. **[20 marks]** *(2017:31)*

(a) DNA is made of units called nucleotides. Draw and label a diagram of a nucleotide. [5]

(b) (i) List the **two** sets of complementary base pairs that occur in DNA molecules. [2]

One: _____

Two: _____

(ii) Name the type of chemical bond that links the complementary base pairs in a DNA molecule. [1]

_____

(iii) Name the base in mRNA that is complementary to thymine in DNA [1]

_____

CONTINUED NEXT PAGE

(c) Describe the structure of mRNA. [3]

(d) Describe the role of tRNA in protein synthesis. [4]

(e) A study has shown that barn swallows living in an area contaminated by nuclear radiation have a high incidence of abnormalities compared with those in uncontaminated areas.

Provide a plausible explanation for the higher incidence of abnormalities in the barn swallows that live in the contaminated area. [4]

38. [4 marks] *(2017:33)*

Biologists suspected that a species of fruit fly was developing resistance to a commonly-used insecticide. They collected 1000 fruit flies from an orchard sprayed regularly with this insecticide. In the laboratory they sprayed the fruit flies from the orchard with the recommended dose of insecticide and measured the percentage survival of the flies over the next 100 hours. At the same time, they also sprayed a group of 1000 laboratory-reared fruit flies of the same species that had never been exposed to insecticide and recorded their percentage survival over the next 100 hours. Fruit flies in both groups were kept under identical culture conditions. The data are shown below.

Time in hours since spraying	% fruit flies from the orchard surviving	% fruit flies from the laboratory surviving
0	100	100
20	97	8
40	51	4
60	50	2
80	49	2
100	49	0

(d) Biologists determined that resistance to the insecticide in the fruit flies was controlled by a single gene but were unsure whether the allele that gave resistance was dominant or recessive to the allele that caused susceptibility.

Describe how the biologists could determine whether the allele that gave resistance was dominant or recessive to the allele that caused susceptibility.

EXTENDED ANSWER QUESTIONS

Each Extended Answer is worth 10 marks.

PART A Questions

39. 2012:37
Protein synthesis involves two stages, **transcription** and **translation**. Describe the main steps in each of these processes.

40. 2013:38
Describe, using scientific terminology, the main steps involved in DNA replication in a living cell.

41. 2014:38
A biologist used DNA data to investigate the relationship between red and gray wolves. Describe how the technique of gel electrophoresis could be used to compare the DNA of these two species.

42. 2016:36a
Describe the structure of DNA and the main steps in DNA replication in a cell.

43. 2016:36b
Describe the process of meiosis and explain how this process produces genetic variation.

44. 2017:36a
Chymosin is an enzyme produced by nursing calves to assist with the digestion of milk. Humans also use chymosin to make cheese. Traditionally, chymosin for cheesemaking was obtained from the stomach of calves that had been killed for their meat. It is now obtained from genetically-modified microorganisms.

Describe how recombinant DNA technology can be used to genetically modify bacteria to produce chymosin and the advantages of obtaining chymosin for cheesemaking in this way.

PART B Questions

45. 2013:41
Genetic variation is a prerequisite for evolution. Mutation is one source of genetic variation and meiosis is another. Name and describe the **two** ways in which meiosis produces genetic variation.

46. 2016:37a
Describe how a cell produces an enzyme.

Continuity of life on Earth

Chapter **2**

- life has existed on Earth for approximately 3.5 billion years and has changed and diversified over time
- evidence for the theory of evolution includes
  - comparative genomics (molecular evidence)
  - the fossil record
  - comparative anatomy and embryology
- evolutionary relationships between groups can be represented using phylogenetic trees
- mutation is the ultimate source of genetic variation as it introduces new alleles into a population
- natural selection occurs when selection pressures in the environment confer a selective advantage on a specific phenotype to enhance its survival and reproduction; this results in changes in allele frequency in the gene pool of a population
- in addition to environmental selection pressures, sexual selection, mutation, gene flow and genetic drift can contribute to changes in allele frequency in a population gene pool
- speciation and macro-evolutionary changes result from an accumulation of micro-evolutionary changes over time
- selective breeding (artificial selection) through the intentional reproduction of individuals with desirable characteristics results in changes in allele frequencies in the gene pools over time
- differing selection pressures between geographically isolated populations may lead to allopatric speciation
- populations with reduced genetic diversity face increased risk of extinction

Chapter 3

Science as a human endeavour

- transgenic organisms have been engineered for desirable traits, including resistance, faster growth rate, greater product quality and yield, and tolerance to adverse environmental conditions
- using transgenic organisms may have adverse effects on genetic diversity and the environment, including
  - the effects on non-target organisms
  - more rapid evolution of pesticide-resistant species
  - the possibility of gene flow from crop species to weed species resulting in the emergence of 'super weeds'
- biotechnology can be used in environmental conservation for
  - monitoring endangered species
  - assessing gene pools for breeding programs
  - quarantine
- technological developments in the fields of comparative genomics, comparative biochemistry and bioinformatics have enabled identification of further evidence for evolutionary relationships
- conservation planning to maintain viable gene pools includes consideration of
  - biogeography
  - reproductive behaviour
  - population dynamics

MULTIPLE-CHOICE QUESTIONS

1. *(2012:15)*

The enzyme DNA polymerase

(a) unwinds DNA by breaking the bonds between base pairs.

(b) breaks DNA up into separate nucleotides.

(c) adds nucleotides to a newly forming DNA strand.

(d) cuts DNA at specific recognition sites.

2. *(2013:17)*

In which order do the three stages of polymerase chain reaction (PCR) occur?

(a) annealing, denaturation, extension

(b) denaturation, annealing, extension

(c) extension, annealing, denaturation

(d) annealing, extension, denaturation

3. *(2013:20)*

Which of the following is a transgenic organism?

(a) a bacterium that has been modified to produce human insulin

(b) a mule that is a cross between a donkey and a horse

(c) an alga that has been introduced into an area in which it did not previously exist

(d) a mosquito with two pesticide resistant alleles at a gene

4. *(2014:27)*

Polymerase chain reaction (PCR) is an artificial method of

(a) DNA repair.

(b) DNA replication.

(c) transcription.

(d) translation.

5. *(2015:10)*

In gene cloning, the main purpose of plasmids is to

(a) identify the gene for cloning.

(b) extract the desired gene from a donor organism.

(c) produce many copies of the desired gene.

(d) introduce the desired gene into a recipient organism.

6. *(2017:25)*

The science of collecting and analysing large sets of biological data is called

(a) bioinformatics.

(b) biotechnology.

(c) comparative biochemistry.

(d) comparative genomics.

SHORT ANSWER QUESTIONS

7. [5 marks] *(2012:31)*

Scientists genetically modified male and female mice so they were able to produce a specific human enzyme called IKKbeta in their fat tissue.

The scientists conducted an experiment in which they fed two groups of mice on the same high fat diet. One of the groups was genetically modified, while the other was not. The mice all started at the same weight and after 22 weeks on the diet, the average weight of the modified mice was 38 g and of the unmodified mice was 45 g. There was no significant difference between males and females.

(e) Before the gene that produces the IKKbeta enzyme could be introduced to mouse DNA it had to be cloned. Describe the steps that were used in the process of cloning the IKKbeta gene.

8. [4 marks] *(2012:34)*

Genetic recombination in eukaryotes occurs via several processes including crossing over and independent assortment of chromosomes during meiosis.

(a) Describe each of these processes and explain briefly how they produce genetic variation.

Crossing over:

Independent assortment:

9. [4 marks] *(2012:35)*

Spotted Wing Drosophila (SWD), a type of fruit fly, is a pest in many fruit crops. These flies are often caught in traps that are baited with wine and/or vinegar to attract them.

(b) Polymerase chain reaction and gel electrophoresis were used to study genetic diversity in SWD.

Explain how the technique of gel electrophoresis separates DNA fragments of different sizes.

10. [3 marks] *(2013:31)*

(d) Evolution, at the species level, is driven by a small number of processes.

Name the evolutionary process that produces

(i) new alleles. [1]

(ii) random changes in allele frequencies. [1]

(iii) adaptive changes in allele frequencies. [1]

11. **[8 marks]** *(2014:34)*

Enderby Island Cattle existed on Enderby Island, south of New Zealand, for over 80 years. This breed of cattle is of interest because of its ability to survive cold conditions. Biologists want to isolate the genes that allow the Enderby Island Cattle to survive in cold conditions and transfer them to other cattle breeds.

(a) (i) What is the term used to describe a species that contains a gene that has been artificially introduced from another species? [1]

(ii) Explain how DNA microarrays can be used to identify the genes that promote cold tolerance in the Enderby Island Cattle. [2]

(iii) DNA microarray technology is relatively new. What is the main advantage of this technology? [1]

(b) A variety of techniques, including restriction enzymes, would be used to transfer a gene from an Enderby Island cow into another cattle breed.

(i) What are restriction enzymes? [2]

(ii) What role would restriction enzymes play in the process of transferring a gene from one organism to another? [2]

12. **[8 marks]** *(2016:35)*

(a) A biologist calculated the percentage similarity in DNA sequence among four species of *Drosophila*. The results are presented in the table below.

Species	Percentage similarity with species 1
1	–
2	95
3	90
4	80

Use these data to construct a phylogenetic tree showing the evolutionary relationships among these species. Draw your tree in the space below. Include a title with your drawing. [4]

CONTINUED NEXT PAGE

A biologist wanted to create a herbicide-resistant strain of canola plant for farming.

(e) (i) Explain an advantage of using DNA recombinant technology, rather than artificial selection, to produce a herbicide-resistant strain of canola. [2]

(ii) Explain a possible adverse environmental effect that could result from farming herbicide-resistant canola. [2]

EXTENDED ANSWER QUESTIONS

Each Extended Answer is worth 10 marks.

PART A Questions

13. 2015:38
Artificial selection and transgenesis (the production of transgenic organisms) are two methods that humans use to change the features of plants or animals. Describe how artificial selection and transgenesis can each be used to change the features of plants or animals.

14. 2017:36b
In making conservation plans to maintain viable gene pools, why do biogeography, reproductive behaviour and population dynamics need to be considered?

UNIT 4

SURVIVING IN A CHANGING ENVIRONMENT

Chapter 1: Heredity

Multiple Choice Questions

1 (2012:01)	(b)	2 (2013:16)	(d)	3 (2013:18)	(c)	4 (2013:22)	(d)
5 (2014:01)	(b)	6 (2014:04)	(c)	7 (2014:11)	(d)	8 (2014:17)	(c)
9 (2014:22)	(c)	10(2015:10)	(d)	11 (2015:22)	(b)	12(2015:23)	(d)
13 (2015:24)	(c)	14(2016:03)	(d)	15 (2016:04)	(a)	16(2016:17)	(b)
17 (2017:01)	(c)	18(2017:04)	(a)	19 (2017:07)	(a)	20(2017:08)	(c)
21 (2017:09)	(a)	22(2017:11)	(c)	23 (2017:13)	(c)	24(2017:14)	(a)
25 (2017:18)	(d)	26(2017:19)	(d)	27 (2017:26)	(d)	28(2017:27)	(a)
29 (2017:28)	(b)						

Short Answer Questions

30 (2012:34) **(4 marks)**

(c) Any four of:
- Identify drought tolerant genes in other species
- Genes are extracted
- These genes are cloned in bacteria
- Insert genes into the chromosomes of rice plants
- Drought tolerance is transferred to the rice plant

31 (2013:31) **(11 marks)**

(a) Any three of: 1 mark each (max 3) (3)
- Both chromosomes and genes are made of DNA
- A chromosome is a long length of DNA/contains many genes
- A gene is a short section of DNA/chromosome

(b) (i) Any one of: (max 1) (1)
- Chromosomes contain different amounts of DNA
- When present in large numbers, the chromosomes may contain little DNA/be small
- When present in small numbers, the chromosomes may contain a lot of DNA/be large
- Chromosome fusion/fission gives same amount of DNA but different chromosome number

(ii) 1 mark each – max 2 (2)
- The more DNA in a cell, the longer the duration of meiosis
- with the exception of bread wheat/except in bread wheat where the duration is shorter than expected (based on the amount of DNA)

(c) (i) Any two of: (1 mark each – max 2) (2)
- It was much slower in the amphibian compared to wheat and onion (all of which had about the same amount of DNA)
- The average duration in the animal species was much longer than in the plant species/the average duration in the plant species was much shorter than in the animal species
- In most of the animal species it took longer than 8 days whereas in most of the plant species it took less than 8 days
- Any accurate numerical quote from the data (1)

(ii) Any two of: (1 mark each – max 2) (2)
- Included a very small number of species/small sample size/need to include more species
- No data for plant and animal species with identical amounts of DNA/most of the plant and animal species had different amounts of DNA
- (Possible) lack of controlled conditions (when taking the measurements)

32 (2013:34) (4 marks)

(c) First three points and one from last list (4)
- The nucleotide sequence of mRNA is in triplets/3's/3 bases (1)
- These three bases/triplets are called codons (1)
- Each mRNA base triplet/codon determines one amino acid (1)

Plus any one of
- Ribosome joins amino acids together/polypeptide chain formed
- Start codon is AUG/all proteins start as methionine
- tRNA carries amino acids to the mRNA
- tRNA contains anticodons which are complementary to the codons (1)

33 (2013:35) (4 marks)

(e) Any four of the following in logical sequence (detail not required) – max 2 if sequence is not correct (4)
- identify the gene/s responsible for salt tolerance
- extract the gene/s from the donor plant (using restriction enzymes)
- insert the gene/s into a vector/plasmid (same restriction enzyme)
- introduce vector to a host/bacterial cell (for cloning/increasing number of genes)
- introduce gene to target species
- salt tolerance becomes part of the target species' genotype

34 (2015:34) (13 marks)

(a) (i) False (1) (2)
Bases are complimentary to the template so a mirror 'image' (1)

(ii) False (1) (2)
Semiconservative involves each of the two daughter molecules having an old strand from the original DNA and one newly made strand. Wrong base implies mutation (1)

(b) (i)
- To amplify/make multiple copies of DNA (1)
- For DNA profiling to test for genetic disorders/DNA fingerprinting/investigating extinct species (1)

(ii)
- Segment of DNA to be copied (1) (3)
- Single stranded DNA primers (1)
- Heat stable DNA polymerase/Taq polymerase (1)

(c) (i)
- Gene – section of DNA that codes for a protein/contains code for synthesis of a polypeptide (2)
- Allele – form of a gene for a particular characteristic having the code for a particular phenotype

(ii)
- Dominant – allele expressed by a heterozygote that masks another allele (2)
- Recessive – allele not expressed in the heterozygote/hidden due to the expression of the dominant allele

35 (2016:31) (16 marks)

(b) any 2 of the following for 2 marks each (4)
- DNA contains the nucleotide thymine (1) RNA contains the nucleotide uracil (1)
- In eukaryotic cells DNA is found in nucleus (1) RNA found in both nucleus and cytoplasm (1)
- DNA is generally made of two strands (1) RNA is a single strand (1)
- DNA contains deoxyribose sugar (1) RNA contains ribose sugar (1)
- DNA can replicate (1) RNA is synthesised from DNA (1)

(c) F_2 phenotypes; Smooth : Wrinkled = 3 : 1 (1)
any 4 of the following for 1 mark each (4)
- S_1 is dominant to S_2
- Parents genotypes; $S_1S_1 \times S_2S_2$
- F_1 genotypes; all S_1S_2
- F_1 cross; $S_1S_2 \times S_1S_2$
- F_2 genotypes; $S_1S_1 : S_1S_2 : S_2S_2 = 1 : 2 : 1$

(d) 1 mark for each of the following (4)
1. x^wy
2. x^+y
3. x^wx^w
4. x^+x^+, x^+x^w (must have both for 1 mark)

(e) any 2 of the following for 1 mark each (2)
- A feature controlled by more than one pair of genes/a feature controlled by genes found at two or more loci
- Phenotype shows continuous variation within the population
- Phenotype shows great variation within the population
- Environment influences the phenotype

1 mark for an example – some appropriate examples are listed below (1)
- Height in humans
- Weight in humans
- Skin colour in humans
- Grain colour in wheat
- Length of corn cob

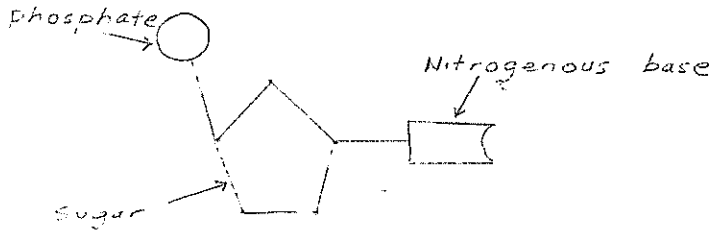
36 (2016:35) (8 marks)

(b) Any 4 of the following for 1 mark each (4)
- A sample of DNA is collected from an organism
- STRs are removed from particular DNA molecules
- The STRs are amplified using PCR
- The amplified samples are placed on gel electrophoresis to produce a banding pattern
- The banding pattern produced is unique to the organism

(d) 1 mark for each of the following (4)
- **Restriction enzyme:** enzyme used to cut a fragment of DNA at a particular recognition site, to remove the gene of interest from a donor organism. It is also used to cut the host DNA in order to allow the fragment to be spliced onto the host DNA
- **Ligase:** enzyme used to join a fragment of DNA to recipient DNA. Ligase can link two segments of DNA or two complimentary strands of DNA
- **Plasmid:** Circular (doughnut) shaped double stranded DNA that is not chromosomal obtained from a bacterium onto which the DNA fragment is spliced. Used as a vector in recombinant DNA technology
- **Vector:** plasmid molecule which contains the recombinant DNA that is incorporated into a bacterium/any means of transferring a gene from one organism to another e.g. Agrobacteria

37 (2017:31) (20 marks)

(a) one mark for each correct label (3)
one mark for correct positioning of the three parts (1)
one mark for large clear neat diagram (1)



(b) (i) one mark for each of the following (in any order)
One: Adenine and Thymine (1)
Two: Guanine and Cytosine (1)

one mark for each of the following
(ii) Hydrogen bond (1)
(iii) Uracil (1)

(c) one mark each for any 3 of the following (3)
mRNA:
- made up of a single strand of nucleotides
- the chain of nucleotides is shorter than the DNA molecule
- uracil replaces thymine in the chain
- start and stop codons are present in the chain
- there is a coding region made up of codons between the starting and stop codons

(d) one mark for each of the following (4)
- tRNA combines with a specific amino acid
- tRNA carries its amino acid to a ribosome on which mRNA is located
- tRNA's anticodon finds its matching codon on the mRNA template
- the amino acid forms a peptide bond with its adjacent amino acid while the tRNA detaches from the amino acid and moves away from the ribosome

(e) one mark each for any 4 of the following (4)
- the radiation contaminated area may show a dangerously high background radiation count
- high radiation levels are likely to damage some DNA molecules in the birds that live in the area as radiation exposure has a cumulative effect
- if damage occurs to DNA in the barn swallows' gametes
- this may cause mutations in the offspring of those barn swallows that have been exposed in the contaminated areas
- uncontaminated areas will not show dangerous levels of radiation and will therefore have a lower incidence of abnormalities

38 (2017:33) **(4 marks)**

(d) One mark for each of the following
- Cross a large number (e.g. several thousand) of fruit flies from a frequently sprayed orchard with a large numbers of fruit flies from the laboratory
- Allow the F1 generation to interbreed and observe the proportion of resistant and non-resistant offspring in the F2 generation
- If the F2 generation shows an approx. ratio of – resistant : non-resistant = 3 : 1 this suggests that the resistant gene is dominant
- If the F2 generation shows an approx. ratio of – resistant : non-resistant = 1 : 3 this suggests that the non-resistant gene is dominant

Extended Answer Questions

PART A

39 (2012:37) **(10 marks)**

Transcription: Any five of: **(max 5)**
- DNA unwinds
- RNA polymerase
- attaches to DNA at a specific region/promoter region/5'
- DNA code is used as a template
- only one strand of DNA is transcribed (antisense strand)
- free nucleotides used to form mRNA
- mRNA forms complementary strand to DNA
- difference is uracil instead of thymine attached to adenine
- transcription stops at terminator sequence on DNA strand
- RNA polymerase/enzyme then detaches from DNA/releases mRNA
- mRNA transported/moves (from nucleus) to cytoplasm

Translation: Any five of: **(max 5)**
- mRNA transported/moves (from nucleus) to cytoplasm (if not awarded above)
- mRNA binds to ribosome
- Bases in groups of 3 per codon
- start codon (mRNA)
- tRNA recognises codon on mRNA
- tRNA contains an anti-codon

- tRNA binds to site on ribosome/P site
- and brings amino acid with it
- a peptide bond forms between the amino acids
- tRNA is released to continue the process

amino acid chain forms a polypeptide/protein

40 (2013:38) **(10 marks)**

First 5 dot points – 1 mark each (max 5)

Description
- The double-stranded DNA unwinds/unzips (1)
- The enzyme DNA polymerase synthesizes the new DNA strand/molecule. (1)
- Each of the two DNA strands/molecules is copied/acts as a template/becomes half of the new DNA molecule. (1)
- The new strand/molecule is complementary to the original/template strand. (1)
- The enzyme ligase joins the stretches of DNA together. (1)

Plus any five of (1 mark each – max 5) (5)
- The DNA (double helix) unwinds at a particular location/the replication fork.
- The DNA strands are coated with a protein (called SSB – single strand binding proteins) that prevents the two strands from re-annealing/keeps the strands separate
- The nucleotides on each strand are now exposed and unpaired/the nucleotide sequence of the exposed strands is copied
- Free nucleotides, present in the nucleoplasm are attached to their complementary bases
- Adenine pairs with thymine, cytosine pairs with guanine
- An enzyme (helicase) unwinds the DNA/facilitates this
- DNA polymerase can only extend a (pre-existing) nucleic acid chain/DNA polymerase cannot synthesis from scratch
- DNA strands have a direction and synthesis only occurs in one direction/DNA synthesis occurs in a 5' to 3' direction.
- One strand is synthesized continuously (leading strand)/one strand is synthesized in short pieces (lagging strand).
- Primers are necessary/Synthesis begins at primers
- Primers are short pieces of RNA/are synthesized by the enzyme primase

41 (2014:38) **(10 marks)**

1 mark for each point (max 10 points)
- DNA is extracted from each species
- DNA is cut into fragments
- Using restriction enzymes
- The same/corresponding fragments from each species
- Are loaded into the gel (wells) at the negative end of the chamber
- An electric current is passed through the gel
- DNA is a large negatively charged molecule
- Moves from negative electrode/terminal to positive electrode
- Different fragments move at different rates
- Small fragments move faster than larger fragments
- This forms specific patterns of bands
- DNA is treated with dye that shows up under UV light
- Thus the DNA of the two species can be compared

42 (2016:36a) **(10 marks)**

DNA structure – 1 mark for any 4 of the following points (4)
- Molecule chain of nucleotides
- Each nucleotide consists of a nitrogen base, a sugar molecule and a phosphate group
- Four types of bases – adenine, thymine, cytosine and guanine
- Most DNA consists of two complimentary strands of DNA
- Two strands form a double helix
- Strands are held together by weak hydrogen bonds
- Adenine bonds to thymine, cytosine bonds to guanine across the strands

Replication – 1 mark for any 6 of the following points (6)

- Replication of each chromosome occurs in the middle stages of interphase
- DNA molecule unzips along its entire length separating its two complimentary strands
- Each single DNA strand becomes a template/process is semi-conservative as each new DNA molecule has one original strand
- Enzyme helicase is used to separate strands
- Free nucleotides in the nuclearplasm move to complimentary bases along each single strand
- Enzyme polymerase is used to join the complimentary bases along each strand
- Hydrogen bonds between the complimentary bases are weak – but their sum total provides sufficient stability
- Along the leading strand (5' to 3') this joining process is continuous, along the lagging strand (3' to 5') it is discontinuous

43 (2016:36b) (10 marks)

Process of meiosis – 1 mark for any 7 of the following points (7)

- Chromosomes replicate during interphase
- Meiosis involves two divisions, before each division the nuclear membrane breaks down
- In the first division diploid cell has homologous chromosomes that form pairs
- Spindles attach to each pair
- Pairs are separated moving to opposite poles of the cell
- Cell divides into two, each cell containing one chromosome of each homologous pair
- In second division new spindles form
- Spindles separate chromatids that move to opposite poles of each cell
- Both cells divide forming a total of 4 cells
- Each new cell (gamete) contains half the number of chromosomes as the parent cell – each is haploid

How meiosis produces genetic variation – 1 mark for any 3 of the following points (3)

- Crossing over – chromosomes exchange genetic material during the first division
- Nondisjunction – some chromosomes/chromatids fail to separate during the first or second cell division
- Random assortment of chromosomes as they form pairs during the prophase of first division
- Mutations in the parent cells (or germ cells) that form gametes

44 (2017:36a) (10 marks)

One mark each for any 8 of the following (8)

- In recombinant gene technology a DNA fragment is integrated into DNA to which it does not normally belong
- To produce chymosin (main enzyme in rennet) the gene which codes for this protein is removed from calf DNA
- The DNA fragments containing the target gene are removed using a specific restriction enzyme
- The DNA fragments are amplified using PCR
- DNA fragments containing the target DNA are then spliced using ligase
- into bacterial plasmid DNA molecules
- The plasmid molecule is cut using the same specific restriction enzyme
- The plasmid molecule with its recombinant DNA is then reintroduced into bacteria
- The bacteria are incubated to produce millions of copies, each time a bacterium divides its DNA is replicated
- Each bacterium has the capacity to produce chymosin which can be extracted for use in cheese making
- The chymosin is then purified – other proteins are removed

One mark each for any two of the following (2)

The advantages include

- The process enables extracts containing almost pure chymosin to be produced
- No need to slaughter calves to produce cheese
- Less likelihood of contamination of chymosin by other harmful bacteria
- More economical process and more cheese can be produced

PART B

45 (2013:41) (10 marks)

Crossing-over (1)

Plus any four of the following – 1 mark each (max 4) (4)

- In the early stages of meiosis/in prophase I/during reduction division
- Chromosomes pair/synapse/attached at chiasmata
- They then exchange/swap sections of DNA/chromatids
- Recognition that the process involves homologous chromosomes/homologous sequence exchange (must mention the word homologous)
- This creates chromosomes with new combinations of alleles/genes (resulting in genetic variation)

Random/independent assortment (1)

Plus any four of the following – 1 mark each (max 4) (4)

- During metaphase I/during reduction division
- Chromosomes align in the centre of the cell
- Chromosomes then move/segregate to different poles
- Recognition that the alignment of the chromosomes is random/the segregation/separation of the chromosomes is random with respect to parental origin
- Recognition that homologous chromosomes move/separate to different poles

(After segregation) the poles/gametes contain a mix of chromosomes from each 'parent' (resulting in genetic variation).

46 (2016:37a) (10 marks)

1 mark for any 2 of the following points (2)

- Enzymes are a type of protein – therefore the production of an enzyme is the same as protein synthesis
- Production takes place in two stages – transcription followed by translation
- Transcription takes place on chromosomal DNA in the nucleus of eukaryotic cells, translation occurs in the cytoplasm on ribosomes

Transcription

1 mark for any 4 of the following points (4)

- DNA unzips along part of its length
- Free nucleotides in the nuclearplasm bond to one side of the exposed DNA molecule
- RNA polymerase speeds up this bonding
- Uracil replaces thymine in molecule formed
- The molecule formed is called mRNA
- mRNA detaches from the DNA – sections of the molecule called introns which do not code for amino acids are removed by enzymes
- mRNA moves through a nuclear pore to a ribosome

Translation

1 mark for any 4 of the following points (4)

- Transfer RNA (tRNA) molecules which have three nucleotides called anticodons transport particular amino acids from the cytoplasm to their corresponding codons along the mRNA molecule
- mRNA forms a template for the synthesised protein so the order and number of amino acids used is correct
- Polymerase promotes the bonding of the nucleotides in the codons and matching anticodons
- Adjacent amino acids delivered by the tRNA molecules form peptide bonds
- When complete the long chain of amino acids detaches from the mRNA – a protein/peptide is formed

- Homologous structures – structures which in embryos may look the same but as different species develop, become different and develop different functions,
- E.g. forelimbs of vertebrates – legs for walking in most mammals, wings for flying in birds – homologous structures indicate common ancestors

Comparative embryology

- Embryology: in the vertebrate group all the embryos are very similar in that they have pharyngeal folds (or gill slits), a post-anal tail and a very similar shape
- This suggests that they have many genes in common
- They therefore have a relatively recent common ancestor

Comparative genomics

- Genomics – the area of genetics involved in studying genomes, DNA sequencing and its use in biology
- Comparison of organisms' DNA, genes and nucleotide sequences enables scientists to more accurately construct phylogenic trees and to determine how closely related species are to one another; that is to determine whether or not they have a recent common ancestor
- Knowledge of the genes in related organisms can help understand which alleles have been naturally selected and which have disappeared in particular populations
- Biochemistry: comparisons of blood proteins, DNA and other compounds within the body of animals and plants, enables links to be drawn
- The observation that all organisms contain DNA suggests a connection between all organisms that may be traced to the beginning of life on earth
- E.g. the similarity of DNA in the primate group indicates that they evolved from a common ancestor (approximately 65 million years ago)

PART B

39 **(2012:40)** **(10 marks)**

Any ten of:

- Genetic variation exists within a species
- Variation is due to gene mutation
- Variation is due to reproductive processes/non disjunction/crossing over/independent assortment
- There is an excessive amount of reproduction with each new generation
- Fish isolated in caves
- Selection pressure now exists
- Those with the best genetic adaptations are most likely to survive and reproduce
- Establish the link between reduction in vision and increase in other senses as being advantageous in dark/cave environment
- More energy available for other senses
- Their offspring will inherit the favourable genes
- Gene frequency of favourable genes will increase
- If a population is reproductively isolated, speciation can occur
- After many generations/a lot of time all/most members of the species are eyeless
- Eyeless population may no longer be able to interbreed with surface population

40 **(2014:41)** **(10 marks)**

Any 10 points for one mark each, but must refer to speciation, not just natural selection, otherwise only maximum of 5 marks.

- speciation has occurred
- mutations occur within populations
- causes variation
- isolation/migration occurs separating ancestral/original species from others
- due to geographical isolation/oceans
- no gene flow occurs
- two different gene pools are created
- environmental conditions differ in different regions
- selection pressures/forces act on different populations
- some adapt/have characteristics/phenotypes that are favourable
- competition occurs for food/space/resources
- only the strongest survive and reproduce

- passing on favourable alleles/increasing incidence of favourable phenotypes
- speciation occurs as species become too different/cannot reproduce
- to produce fertile offspring/interbreed

41 **(2015:41)** **(10 marks)**

Fossils

Any 5 points for one mark each.

- Fossils are any preserved remains of a living organism
- Provide direct evidence of past life on earth
- Usually preserved in rocks of different ages so that they can be aged/time scale can be studied
- Fossils show how much, or how little, organisms have changed over time.
- Demonstrates progressive changes in the structures of animals and plants as they adapt to different/changing environments
- Can provide evidence of the environment/climate in the past eg fossilised pollen grains, plants and coprolites (fossilised faeces)

Embryology of vertebrates

Any 5 points for one mark each.

- Comparative embryology compares the embryos of different species
- And shows the relationship between different species of animals/vertebrates
- Early stages of many vertebrates embryos appear very similar for example they all have gill slits/notochord/tail
- This suggests a common ancestor embryos sometimes have structures that are inappropriate for their adult form but that show their relatedness to other animals.
- The more similarities in later embryonic forms of different vertebrates demonstrates that they had a more recent common ancestor

Chapter 3: Science as a human endeavour

Multiple Choice Questions

1 (2012:15)	(c)	2 (2013:17)	(b)	3 (2013:20)	(a)	4 (2014:27)	(b)
5 (2015:10)	(d)	6 (2017:25)	(a)				

Short Answer Questions

7 **(2012:31)** **(5 marks)**

(e) Gene cloning

Any five of:

- Restriction enzymes cut the DNA
- Plasmid also cut by restriction enzymes
- DNA inserted using DNA ligase
- Plasmids inserted into cells/vector
- Cells multiply
- Multiple copies of gene made

8 **(2012:34)** **(4 marks)**

(a) Crossing over

- Involves exchange of DNA segments/alleles/sections of chromatid between homologous chromosomes (1)

Crossing over

- Each chromosome can be a blend of maternal and paternal DNA/creates new combinations of alleles (1)

Independent assortment

- Random combinations of maternal and paternal chromosomes
- chromosomes align randomly
- independently on each side of equator (1)

Independent assortment

- Produces a very large range of variation in gametes (1)

9 (2012:35) (4 marks)

(b) Any four of:
- DNA fragments have a small electric charge
- DNA fragments are (able to move when) placed in a gel
- A weak electric field is applied to the gel
- This pulls the fragments to one end of the gel
- Fragments move at different rates depending on size
- Smallest fragments move faster/further/offer less resistance
- Separates fragments into a unique pattern for that species

10 (2013:31) (3 marks)

(d) (i) • Mutation (1)

(ii) • Genetic drift/Random genetic drift/bottleneck/founder effect (1)

(iii) • Natural selection/selection/ sexual selection (1)

11 (2014:34) (8 marks)

(a) (i) Transgenic (1)

(ii) • Collect cell samples from Enderby Island Cattle and another breed not cold tolerant (1) (2)
• Use DNA microarray to measure gene expression in both samples/ identify genes expressed in E.I. cattle but not in other breed (1)

(iii) • Much faster than other technologies (1) (2)
• Able to test for the presence and/or expression of thousands of different genes at the same time (1)

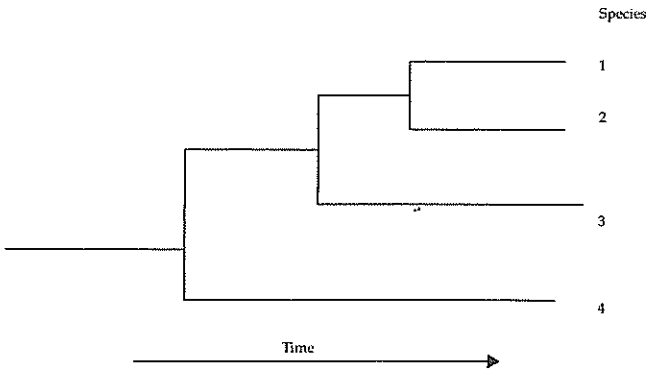
(b) (i) • Proteins/enzymes that recognise specific/short nucleotide sequences (2)
• Cut DNA only at specific recognition site
• Act as molecular scissors (1)

(ii) • Recognises the sequence of bases and cuts gene/isolates the gene (2)
• Cuts same sequence in plasmid/vector to insert gene

12 (2016:35) (8 marks)

(a) 1 mark for title and labels, 1 mark for each of the 3 correct branches (4)

Phylogenic Tree – Evolutionary relationship between 4 species of Drosophila



(e) (i) 1 mark for advantage 1 mark for explanation (2)
- DNA technology is faster and less costly
- It does not require many generations to establish a herbicide resistant population

or

- DNA technology is more precise/less hit and miss
- Target organism remains unchanged apart from its herbicide resistance/effects of inbreeding are avoided

(ii) 1 mark for adverse environmental effect 1 mark for explanation (2)
- Genes for herbicide resistance may be transferred to weeds in the environment
- Some weeds can no longer be eliminated using this herbicide

or

- Establishment of herbicide resistant crops may encourage growers to use more herbicides
- May result in greater contamination of food/rapid development of herbicide resistant weeds

Extended Answer Questions

PART A

13 (2015:38) (10 marks)

Artificial Selection

1 mark for each point (max 5 points)
- Artificial selection is the process by which humans use animal and plant breeding to selectively develop particular phenotypic traits (features/characteristics)
- by choosing which animal or plant males and females will sexually reproduce and have offspring together.
- involves the breeder or experimenter applying a known amount of selection to a single phenotypic trait by examining the chosen trait/feature
- and choosing to breed only those that exhibit higher or increased signs of that trait
- such that the trait is more common throughout the stock.
- techniques such as inbreeding, linebreeding, and outcrossing are used.

Transgenesis

1 mark for each point (max 5 points)
- transgenic species is a species that has genes from another species added to its genetic code/DNA
- the gene for the required characteristic/feature/trait is isolated
- it can be injected into the nuclei of egg cells or early embryo to become part of the DNA
- thus the resulting offspring has the desired trait
- it can be achieved by using plasmids from bacteria
- the selected section of DNA (that codes for the trait) is isolated from the donor cell
- and inserted into the plasmid to produce recombinant plasmids
- these are introduced into bacteria that reproduce to produce clones of the desired gene

14 (2017:36b) (10 marks)

Biogeography

One mark each for any three of the following (3)
- Understanding an organism's geographic distribution enables an understanding of its tolerance to biotic factors in that area
- E.g. Foods it needs, ability to survive predation, competition
- Understanding an organism's geographic distribution enables an understanding of the organism's tolerance to the abiotic factors present in its environment
- E.g. the effect of temperature and other climatic factors are better understood

Reproductive behaviour

One mark each for any four of the following (4)
- Understanding when an organism reproduces in order to ensure survival of its offspring
- What its needs are in order to feed and protect its young
- The requirement for nests
- How long it nurtures its young
- Extent of its parental care

Population dynamics

One mark each for each of the following (2)
- Knowledge of the birth and death rates enable estimates of the population's expected growth rate
- Measures may be necessary to increase the birth rate and decrease the death rate of a population if it is to grow

One mark for the following (1)
- An understanding of each of these three areas enables conditions to be created which may ensure conservation plans effectively maintain viable gene pools.