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LIST OF APPENDICES

Appendix I: Summary of samples involved in the study

Purpose of sample	Number of schools	Number of learners				Number of educators
		Grade	Girls	Boys	Total	
Determination of study topic	10	12	30	37	67	10
Pilot study and validation of study instruments	1	11	20	16	36	
Determination of contexts for use in the study	2	12	34	38	72	-
Control group (C)	3	11	54	49	103	3
Experimental group (E)	3	11	55	32	87	3
Learner focus group interviews	6*	11	37*	21*	58*	-
Educator personal interviews	3*	-	-	-	-	6*
Total number of participants	19		193	172	365	16

* Not included in calculating the total number of participants because they form part of the samples of the experimental and control groups.

Appendix II: Selection of difficult life sciences topics (concepts)

Please indicate whether you are a learner or an educator by ticking in the appropriate box.

Educator ☐ Learner ☐

Select the ten (10) most difficult life sciences topics according to your opinion, from the following list, by writing 1 in the box representing the most difficult topic, 2, in the box representing the next most difficult topic, until you reach the tenth most difficult topic.

Topic (Concept)	Rank
Molecules for life	
Cell structure and function	
Cell division - mitosis	
Plant and animal tissues	
Human diseases	
Indigenous knowledge systems	
Organs	
DNA structure	
Meiosis	
The genetic code	
Photosynthesis	
Nutrient cycles and energy flow	
Animal nutrition (Mammals)	
Homeostasis in humans	
Cellular respiration	
Gaseous exchange	
Support and transport in plants	
Support systems in animals	
Transport in mammals	
Excretion in humans	
Reproduction in vertebrates	
Reproduction in plants	
Human influence on the environment	
Human endocrine system	
The human nervous system	
Biosphere, biomes and ecosystems	
Population ecology	
Biodiversity and classification of animals	
Biodiversity and classification of plants	
Biodiversity and classification of micro-organisms	
Palaeontology (study of fossils)	
Geological time scales	
Life's history	
Mass extinctions	
Genetics and inheritance	
Evolution by natural selection	
Human evolution	

Appendix III: Ranking of life sciences topics according to perceived degree of difficulty

Life sciences topic (Concept)	Percentage of respondents					Rank
	Educators		Learners		Av.	
	No	%	No	%	%	
Chromosomes, DNA, and gene structure and function	7	70	46	69	69.5	**1**
The genetic code	6	60	49	73	66.5	**2**
Cellular respiration	6	60	46	69	64.5	**3**
The human nervous system	6	60	45	67	63.5	**4**
Meiosis	5	50	41	61	55.5	**5**
Genetics and inheritance	5	50	41	61	55.5	**5**
Human endocrine system	5	50	40	59	54.5	**6**
Biosphere, biomes and ecosystems	5	50	39	58	54.0	**7**
Population ecology	6	60	32	48	54.0	**7**
Biodiversity and classification of plants	4	40	45	67	53.5	**8**
Biodiversity and classification of animals	4	40	44	66	53.0	**9**
Evolution by natural selection	5	50	32	48	49.0	**10**
Photosynthesis	4	40	35	52	46.0	**11**
Palaeontology (study of fossils)	3	30	40	59	44.5	**12**
Geological time scales	3	30	29	43	36.5	**13**
Cell division - mitosis	2	20	34	50	35.0	**14**
Reproduction in plants	2	20	31	46	33.0	**15**
Nutrient cycles and energy flow	2	20	29	44	32.0	**16**
Human evolution	2	20	28	42	31.0	**17**
Biodiversity and classification of micro-organisms	4	40	12	18	29.0	**18**
Molecules for life	1	10	23	34	22.0	**19**
Animal nutrition (Mammals)	1	10	21	32	21.0	**20**
Reproduction in vertebrates	1	10	21	31	20.5	**21**
Support systems in animals	1	10	19	28	19.0	**22**
Life's history	1	10	19	28	19.0	**22**
Gaseous exchange	1	10	17	26	18.0	**23**
Human diseases	2	20	10	15	17.5	**24**
Mass extinctions	1	10	15	23	16.5	**25**
Excretion in humans	1	10	13	19	14.5	**26**
Indigenous knowledge systems	1	10	12	18	14.0	**27**
Support and transport in plants	1	10	11	17	13.5	**28**
Cell structure and function	1	10	11	16	13.0	**29**
Plant and animal tissues	1	10	9	14	12.0	**30**
Homeostasis in humans	0	0	16	24	12.0	**30**
Human influence on the environment	0	0	10	15	7.5	**31**
Organs	0	0	9	13	6.5	**32**
Transport in mammals	0	0	9	13	6.5	**32**

Appendix IV: Questionnaire for preferred learning contexts in genetics

Age ☐ **Gender** ☐

For each statement in the following table, indicate whether, in your opinion, it is important, not important or whether you are undecided concerning its potential (likelihood) to make the study of genetics interesting, relevant, understandable and meaningful. Indicate your opinion by marking a tick under the appropriate option.

Item number	Item (context) statement	Options		
		Not Important	Un-decided	Important
C1	Earn lots of money			
C2	Famous scientists and their lives			
C3	Animals and plants in my area			
C4	How genes help in the formation of my characteristics			
C5	How genetics can be used to control epidemics and diseases			
C6	Very recent inventions and discoveries in genetics and technology			
C7	How to develop or improve my knowledge and abilities in genetics			
C8	How genetics affects the build and functions of the human body			
C9	Improve my grades in exams			
C10	The role of genes in evolution			
C11	The role of genetics in my personal relationships			
C12	The origin and evolution of life on earth			
C13	To further my education			
C14	The use of genetics in crime fighting			
C15	A satisfying career			
C16	Study of the human genome			
C17	Genetic decisions and ethics			
C18	Becoming famous scientist			
C19	Achieve lifelong education			
C20	Cloning of animals			
C21	What I need to eat to keep healthy and fit			
C22	How genes are passed from one person to another			
C23	To secure a marketable career			
C24	The number of degrees I have			
C25	How genes can determine the sex of my child			
C26	Poisonous plants in my area			
C27	Cloning of humans			
C28	Gene therapy (curing disease using genes)			
C29	Well-paying jobs			
C30	The extinction of species			
C31	The cure of human diseases			
C32	Formation of new species (organisms)			
C33	Genetics-related jobs			
C34	How organisms and the environment depend on each other			
C35	The role of genetics in sex and reproduction			
C36	The diversity of organisms			
C37	How genes help my body to grow and mature			
C38	Coming up with new ideas			
C39	Transmission of genetic diseases			
C40	Use of genetics to become rich			
C41	The causes of disease in animals and plants			
C42	Use of genetics to Improve food production			

THANK YOU FOR YOUR PARTICIPATION IN THE STUDY

Appendix V: Mean scores and percentages of learners who selected each item (context) statement

Item	Item (context) statement	Context Theme	Mean Score	% of learners who selected the options		
				Important	Un-decided	Not Important
C1	Earn lots of money	CP	1.5	31.2	5.2	63.6
C2	Famous scientists and their lives	AE	1.2	40.1	1.5	58.4
C3	Animals and plants in my area	EI	1.4	47.8	3.2	49.0
C4	How genes help in the formation of my characteristics	PB	3.0	99.9	0.0	0.1
C5	Life outside earth	ST	1.3	21.4	0.3	78.3
C6	Very recent inventions and discoveries in genetics and technology	ST	2.9	95.0	0.0	5.0
C7	How to develop or improve my knowledge and abilities in genetics	AE	1.3	33.7	0.4	65.9
C8	How genetics affects the build and functions of the human body	PB	2.9	94.0	0.0	6.0
C9	Improve my grades in exams	AE	1.5	48.0	0.0	52.0
C10	The role of genes in evolution	ST	2.1	49.0	0.8	50.2
C11	The role of genetics in my personal relationships	PB	2.7	58.3	0.2	41.5
C12	The origin and evolution of life on earth	ST	1.7	21.4	3.3	75.3
C13	To further my education	AE	1.0	18.1	0.9	81.0
C14	The use of genetics in crime fighting	SI	2.9	98.9	0.1	1.0
C15	A satisfying career	CP	1.1	33.1	0.1	66.8
C16	Study of the human genome	ST	2.9	97.0	0.3	2.7
C17	Genetic decisions and ethics	SI	2.3	86.3	5.2	8.5
C18	Becoming famous scientist	CP	1.2	47.0	0.2	52.8
C19	Achieve lifelong education	AE	1.1	9.5	0.1	90.4
C20	Cloning of animals	ST	2.8	100	0.0	0.0
C21	What I need to eat to keep healthy and fit	PB	3.0	96.9	0.0	3.1
C22	How genes are passed from one person to another	SI	2.6	98.2	0.1	1.7
C23	To secure a marketable career	CP	1.1	29.3	2.8	67.9
C24	The number of degrees I have	AE	1.2	36.0	0.6	63.4
C25	How genes can determine the sex of my child	PB	2.8	99.6	0.4	0.0
C26	Poisonous plants in my area	EI	1.8	43.0	0.0	57
C27	Cloning of humans	SI	2.8	97.4	1.0	1.6
C28	Gene therapy (curing disease using genes)	ST	2.7	99.6	0.3	0.1
C29	Well paying jobs	CP	1.3	51.2	0.9	47.9
C30	The extinction of species	EI	2.4	76.9	0.4	22.7
C31	The cure of human diseases	PB	2.8	97.9	0.7	1.4
C32	Formation of new species (organisms)	EI	2.6	89.0	0.5	10.5
C33	Genetics-related jobs	CP	1.1	49.6	3.1	47.3
C34	How living organisms and the environment depend on each other	EI	2.7	73.0	0.5	26.5
C35	The role of genetics in sex and reproduction	SI	2.5	91.2	0.7	8.1
C36	The diversity of organisms	EI	2.3	87.8	0.7	11.5
C37	How genes help my body to grow and mature	PB	2.9	96.7	0.2	3.1
C38	Coming up with new ideas	AE	1.3	51.0	0.0	49.0
C39	Transmission of genetic diseases	SI	2.7	98.1	0.1	1.8
C40	Use of genetics to become rich	CP	1.2	56.0	2.3	41.7
C41	The causes of disease in animals and plants	EI	2.3	40.3	9.9	49.8
C42	Use of genetics to Improve food production	SI	2.6	68.9	0.0	31.1

APPENDIX VI: EXAMPLES OF GENETICS CONTEXT- BASED LESSONS

NOTE: THE COMPLETE CONTEXT- BASED TEACHING AND PRACTICAL MANUALS CAN BE PROVIDED ON REQUEST

UNIT STRUCTURE

Table 1: Unit themes and relevant genetics content

	Theme	Relevant genetics content
1	Variations in the characteristics of individuals	Environmental factors affecting characteristics, transcription, mRNA, Genetic code, codons and anticodons, Translation, Synthesis of proteins, Enzyme structure and function, chromosomal and genetic mutations, Effect of enzymes on chemical reactions in the body
2	Inheritance of characteristics (including sex determination)	Gamete formation – Meiosis; composition of the egg and sperm. Inheritance – Fertilization, homologous chromosomes, DNA replication and mitosis (growth), Mendel's experiments, Monohybrid inheritance, Dihybrid inheritance, Genotypes and phenotypes, Allelomorphic pairs (alleles), Mendel's laws, Dominant and recessive alleles, Complete, Incomplete dominance and Co-dominance, Crosses, test cross and the use of punnet squares, Patterns of inheritance – Proportions and predictions
3	Determination of blood groups	Alleles - Multiple alleles, ABO blood types, Antigen, A and B, Antibodies, Effects of blood transfusion, Universal donors and recipients, Rhesus factor (Rh+ and RH-)
4	Genetic diseases (Protein deficiency diseases)	Sex linked characteristics, Autosomal traits, Mutations definition, Chromosomal mutations (monosomy, trisomy, polyploidy), Abnormal sex chromosomal inheritance (XO, XXY, XXX, Changes in DNA structure (inversions, translocation, deletions, duplications, insertions, Causes of mutations, Consequences of mutations, Protein synthesis and structure and function, Enzymes, Pedigrees, Sex-linked characteristics, Common genetic diseases (Cystic fibrosis, Sickle cell anaemia, Colour blindness, haemophilia)
5	Genetically modified organisms	Monohybrid inheritance, Genetic probabilities, Autosomal disorders, Characteristics of Huntington disease (late onset, dominant trait), Genetic ethical issues
6	Cloning of organisms	Gene structure, Genetic engineering, Procedure for producing genetically modified organisms, Safety of genetically modified foods, Effect of genetically modified organisms on biodiversity, Ethical issues
7	Determination of offenders using genetics (Fingerprinting and forensics)	Genetic engineering, Procedure for 'reproductive cloning' of organisms, Procedure for 'therapeutic cloning' Genetic ethical issues
8	Genetic counselling, decisions and ethics	Chromosome structure, Protein synthesis, Blood typing, Finger-printing, DNA testing, Permanent and changeable characteristics.

Lesson example 1

9.2 TOPIC TWO: INHERITANCE OF CHARACTERISTICS

OBJECTIVES

At the end of this theme, learners should be able to:

1. State the stages of meiosis.
2. Explain how characteristics are inherited by offspring from their parents.
3. Distinguish between recessive and dominant genes.
4. Explain how a baby's sex is determined.
5. Describe mitosis and its link to the development (growth) of an embryo.
6. Differentiate between genotype and phenotype.
7. Briefly explain Mendel's monohybrid inheritance experiments.
8. Solve genetics problems.

9.2.1 INHERITANCE OF CHARACTERISTICS

Phase 1 Introduction of contexts

Mind capture

Ask learners to compare the characteristics (complexion, height, weight, eye colour and size, weight, and any other characteristics) of children with parents, grandparents and other family members (cousins, aunties and uncles) in table form. Ask learners to determine who resembles whom in the family, and for which characteristics.

Narrative

Nolwazi has been married to Jabulani for 30 years. They have four children named Betty, John, Beauty and James. Beauty and Betty look alike, and they share many features with their mother Nolwazi. John looks more like the father, Jabulani. However, James is an albino, just like his uncle Sipho, Jabulani's brother. Jabulani wonders how his son could have taken after the features of his brother, Sipho, when himself, and his wife Nolwazi are not albinos. He wonders whether his wife had a secret affair with his brother, Sipho.

Phase 2 Interrogation of contexts

Learners should discuss and attempt to provide answers to the following questions, and other questions which might arise. They should write down their answers for reference in phase 4.

1. Why do some members of the same family share common features, while others within the family may not have those features?
2. Why do some children have characteristics from both parents?
3. Do you think it is possible for James to be an albino, without Nolwazi his mother having an affair with her brother in-law, Sipho?
4. Why do some children look like their uncles, aunties or grandparents, but may not look like their own parents?
5. Why are people who are closely related usually not allowed to get married?

Phase 3 Introduction of content

Where do chromosomes in an individual come from?

- Gamete formation – meiosis; segregation, composition of the egg and sperm
- Inheritance – fertilization
- Homologous chromosomes
- DNA replication and mitosis (growth)

How are characteristics inherited from parents?

- Mendel's experiments
- Monohybrid inheritance
- Dihybrid inheritance
- Genotypes and phenotypes
- Allelomorphic pairs (alleles)
- Mendel's laws
- Dominant and recessive alleles
- Complete, incomplete dominance and co-dominance
- Crosses, test cross and the use of punnet squares
- Patterns of inheritance – Proportions (ratios) and predictions

Practical 2 Inheritance and variation of characteristics
(See the practical manual)

Phase 4 Linkage of content and context

Refer back to the questions in phase 2, and ask learners to review the questions in the light of the information provided. Learners should re-examine each question and decide on the following:

1. Do you consider your initial answers and views to be correct or wrong?
2. If you think they are wrong, what would be the appropriate answers and why?
3. Does the information provided link up with or clarify the situations presented earlier?

4. Are there any questions that you would like to ask which may not be answered using the information provided?

Phase 5 Assessment of learning

1. Draw a punnet square for a cross between a tall pea plant (Tt) and a short (tt) plant. What will the genotypes and phenotypes of the offspring be?

2. Dark hair (H) dominates fair hair (h) - which is recessive. A male with hybrid dark hair mates with a female with pure fair hair.
   (i) What are the genotypes of the male and female in this couple?
   (ii) What is the chance that their offspring will have dark hair?

3. Brown eyes (B), dominates blue eyes (b).
   (i) If one parent has pure brown eyes and the other has pure blue eyes, what are the possible genotypes of the offspring?
   (ii) If the children from these parents married, what would the genotypic and phenotypic ratios of their offspring be?
   (iii) If both parents have brown eyes and their children have blue eyes, what could the genotypes of the parents be?

4. If a snapdragon that produces white flowers is crossed with one that produces red flowers, all the offspring are pink.
   (i). What are the genotypes of the parents and the offspring?
   (ii). If two snapdragons with pink colours are crossed, what will the ratios of the genotypes and the phenotypes of their offspring be?

5. A certain species of bird has three colour types: yellow; blue and green. These colours are determined by a pair of genes: yellow (Y) and (B) blue.

   (i) What are the phenotypes of:

   (a) a yellow bird? (b) a blue bird? (c) and a green bird?

   (ii) If a yellow bird is mated with a green bird, what colours can their offspring be?

   (iii) If two green birds are mated,
   (a) What colours can their offspring be?
   (b) What percentage of the offspring would you expect to be green? Explain.
   (iv) If the birds produced four offspring, is it possible that all four could be green? Explain.

Lesson example 2

9.2.2 SEX CHROMOSOME AND DETERMINATION OF A CHILD'S SEX

Phase 1 Introduction of contexts

Mind capture

Ask learners to list the number of males and females in their families (nuclear or extended). Are the numbers of males and females in the families equal? Which sex is predominant?

Narrative

Mr and Mrs Sizwe have been married for twenty years, and they have four daughters, but no son. This situation worries Mr Sizwe, because, according to his custom, having no son means that there will be nobody to take over as his heir when he dies. Mr Sizwe decided to consult his elders about the situation, and they advised him to marry a second wife, who could bear him a son. To his dismay, the second wife gave birth to a girl.

Phase 2 Interrogation of contexts

Ask learners to discuss and attempt to provide answers to the following questions.

1 Who is responsible for determining the sex of a child (the husband or wife)?
2 Why do some couples have only girls or only boys?
3 Is it possible for a couple to decide whether to have a girl or a boy?
4 What would you advise a friend with a problem similar to that of Mr and Mrs Sizwe to do for the sake of family stability?
5 How is the sex of a child determined?

Phase 3 Introduction of content

- Human karyogram
- X and Y chromosomes
- Segregation during meiosis
- Fertilisation of egg by the sperm
- Sex determination
- Monohybrid inheritance of characteristics

Phase 4 Linkage of content and context

Having learned the principles that govern sex determination, consider the questions in phase 2 (context interrogation phase), and attempt to answer them again. Discuss your answers with your group members, and agree on group answers.

1 Do you still maintain the answers given earlier?
2 If the answer is yes, explain why you think your original answers are correct.
3 If not, why have you decided to change your answers?
4 Do you have any questions which cannot be answered from the information provided?

Phase 5 Assessment of learning

1. How does the chromosome set of the human female differ from that of the male?
2. Explain why the offspring of a donkey and a horse are infertile?
3. Why is the chance of a human baby being a boy or a girl about 50% each?
4. A normal body cell of a certain organism has 38 chromosomes. How many chromosomes will be in the sex cells of this organism?
5. A child is born with both male and female reproductive organs. Explain what could have caused this anomaly?

Lesson example 3

9.3 TOPIC THREE: DETERMINATION OF BLOOD GROUPS

OBJECTIVES:

At the end of this theme, learners should be able to:
1 State the different blood types
2 Show an understanding of the phenomenon of multiple alleles
3 Show an understanding of the inheritance of blood types
4 Distinguish between antigens and antibodies
5. Explain the cause of agglutination (coagulation) during blood transfusion
6 Explain the need to match donor and recipient's blood during blood transfusion

Phase 1 Introduction of contexts

Mind capture

- Ask learners to give their blood groups if they know them.
- Ask them why people have different blood group**s**
- Inform learners that people's blood groups are divided into four categories, namely type A, type B, type AB and type O.

Narrative

Two baby girls were born in Baragwanath hospital, to Mrs Mathe and Mrs More. Unfortunately the nurses did not label the babies properly and they were mixed up. All the other babies born on that day were boys. The hospital staff is not sure which baby belongs to which parent. Both Mrs Mathe and Mrs More have blood type **A**. Mr Mathe's blood type is **AB**, whereas Mr More's blood type is **A**. The blood type of baby girl 1 is **O**, and that of the baby girl 2 is **B**. The parents want to know which baby is their real child. How can this situation be resolved?

Phase 2 Interrogation of context

What are your views about the following issues? (Discuss as a class or in groups).

1. Given the information above, how can you determine which baby belongs to which parent?
2. What are the reasons for your conclusion?
3. If Mrs Mathe had blood group O, would it be possible for baby girl 1 to be her child?
4. At the time of this confusion, baby girl 2 develops severe anaemia which requires blood transfusion. Would you advise the mothers to donate their blood to her?
5. Provide reason(s) for your answer.

Phase 3 Introduction of content

- Alleles – multiple alleles
- ABO blood types
- Antigen, A and B
- Antibodies
- Effects of blood donation (blood donation and agglutination)
- Universal donors and recipients

Practical 3 DNA structure and replication - (See the practical manual)

Phase 4 Linkage of content and context

Learners should use the information learned to attempt to answer the questions from phase 2. Find out from the learners whether:

1 There is any difference between their initial and current answers. Why?
2 They used new information in clarifying the questions.
3 They have any questions that could not be answered from the information provided?

Phase 5 Assessment of learning

1 A child has blood group AB, The parents

A must be A and B, but not AB.
B must both be blood groups AB.
C. can have different blood types, but neither can be blood type O.
D. can have any of the four blood types.

Explain your answer.

2 Susan, a mother with blood type B, has a child with blood type O. Susan claims that Graig, who has blood type A, is the father of her child. Graig says that he cannot possibly be the father of a child with blood group O. Susan sues Graig for child support. Further blood tests ordered by the judge reveal that Graig is homozygous A. The judge should rule that:

A Susan is right, and Graig must pay for child support.
B Graig is right, and must not pay for child support.
C Susan cannot be the real mother of the child. Her real child could have been swapped with another in the hospital when the child was born.
D It is impossible to reach a conclusion based on the limited information available.

Explain your answer.

Lesson example 4

9.5 TOPIC FIVE: GENETIC COUNSELLING, DECISIONS AND ETHICS

OBJECTIVES

At the end of this theme, learners should:

- Be able to work out genetic inheritance probabilities
- Show an understanding of the non-absolute nature of genetic predictions
- Demonstrate an understanding of the ethical implications of decisions based on genetic tests and probabilities
- Display an understanding of the medical importance of decisions based on genetic test results
- Reveal the ability to base decisions on facts

Phase 1 Introduction of contexts

Mind capture

Remind learners about the abnormalities, disorders or diseases that are common in their own communities, and ask them what they would do if they knew that they were expecting a child with one of the serious genetic abnormalities cited.

Narrative: The dilemma of Huntington's disease

(Adapted from Salters-Nutfield Advanced Biology, 2005. snab-cpd2-fac-9613)

Huntington's disease is a dominant genetic trait. Carriers of the affected allele will develop symptoms at some stage in their life. The typical age for the onset of the symptoms is between 35 and 45. Sick people develop involuntary tremors (shivers) of the limbs, and personality alterations, outbursts of crying, unexplained anger, memory loss, and sometimes schizophrenic behaviour. The severity of the symptoms at the various stages of the disease differs from one person to another. Death usually occurs at around the age of 50. In their final years of life, patients are in a vegetative state.

Sedibeng, Palesa's grandfather, became ill with Huntington's disease at the age of 45. He passed away when he was 51 years old. Palesa, who is now 22 years old, is about to get married. She would like to be tested in order to find out whether she is a carrier of the disease, so that she can plan her future. She has to decide whether she should continue with her studies for many years, so that she may acquire a profitable profession, or get married and enjoy the remaining years of her life. If she gets married, should she have children or give up the maternal experience.

Mpho, Palesa's father, does not want to find out whether he is a carrier of the Huntington's gene. He believes that if he finds out that he will soon be ill, like his father, he might not enjoy the few years that he could still live a healthy life. He therefore discourages his daughter, Palesa, from being tested.

Phase 2 Interrogation of contexts

You have been asked to advise Palesa on the following issues.

1. Should Palesa be tested for Huntington's genes or not? Why?
2. If Palesa decides not to undergo a Huntington's disease test, would you advise her to continue with her education for many years or would you suggest that she just gets married and enjoys life?
3. If Palesa decides to get married without being tested, would you advise her to have children or not.
4. If Palesa tests positive for Huntington's disease would you advise her to have children or not?

For each of the above questions, find out from the learners who are for the idea and those who are against it. Then let the two groups debate the issues, providing reasons to back up their views.

Phase 3 Introduction of content

- Monohybrid inheritance
- Genetic probabilities
- Autosomal disorders
- Information on the characteristics of Huntington disease (late onset, dominant trait)
- Genetic ethical issues

Phase 4 Linkage of content and context

Ask learners to sit according to the groups formed in phase 2, and ask them to review their answers to each question. If there are any changes to the original answers, ask them to explain why they decided to change their answers. Find out if learners are able to link the information in phase 3 to the context provided in phase 1.

Phase 5 Assessment of learning

Cystic fibrosis (CF) is a common autosomal recessive genetic trait. CF causes a deficient functioning of the external secretion glands, resulting in the production of salty sweat, digestion disorders, and the production of large quantities of mucus in the respiratory tracts. The excessive production of mucus causes frequent lung infections. Each lung infection adds to the long-term damage of the lungs. The disease is therefore lethal and patients rarely survive past the age of 40. There is no cure for cystic fibrosis. However, scientists are investigating the possibility of curing the disease using gene therapy.

(Adapted from Salters-Nutfield Advanced Biology, 2005. snab-cpd2-fac-9613.)

Learners should answer the following questions based on the above passage.

Claassen and Susan got married recently, and both have brothers who have cystic fibrosis (CF). Susan is now pregnant. Genetic tests show that Claassen and Susan are both carriers of a CF trait, and that the embryo is homozygous for the CF trait.

1. Given the knowledge of the genotypic status of the embryo, what would you advise Susan to do about the pregnancy?
2. If your friends disagree with your advice to Susan, how would you react to their alternative views?
3. What moral problems should the parents consider in making decisions about the embryo?

Lesson example 5

9.8 TOPIC EIGHT: IDENTIFICATION OF OFFENDERS USING GENETICS

OBJECTIVES

At the end of this theme, learners should be able to:

1. Appreciate the role of science in solving crime
2. Explain the different ways of using genetics to solve crime
3. Describe the process of DNA testing
4. Link fingerprinting to variations in characteristics

Phase 1 Introduction of contexts

Mind capture

Science is often used in communities to solve crimes, such as murder, armed robberies, drug trafficking, and road accidents. This kind of science is called forensic science. The evidence from forensic science may be used to convict criminals or to prove a suspect's innocence.

Narrative: Who killed granny? (Based on a real-life story)

A 65-year-old grandmother was found dead in her house in Makweng in Polokwane. A closer look at the body suggested that she had been strangled. A forensic investigator was assigned to investigate the murder. On inspecting the body he found bruises on her neck, which supported the suspicion that the cause of death was strangulation.

The forensic investigator noticed a bite mark on the forearm of the victim. He swabbed it to collect some saliva for testing. He also discovered some skin and blood under the fingernails of the victim's right hand, and brown a hair strand in the clenched fist of her left hand.

The investigator collected all these samples, together with the victim's blood, and fingerprints found on the victim's necklace. He sent these samples to the laboratory for analysis. The results from the samples showed that:

1 The victim's blood type was A
2 The blood found under her nails was type B
3 Some blood cells from the blood under the nails were sickled (deformed)
4 The hair found in her hand was brown in colour, while her hair was grey.
5 The cells found in the saliva showed that the perpetrator was a male.
6 The fingerprints were not clear

A week later the local detective brings four suspects, who were seen around the murder scene at the time of the crime, to the forensic investigator. He asks him to determine the likely murderer using forensic evidence. The forensic investigator asks for blood and hair samples from the four suspects. He labels these samples A, B, C, and D, and sends them to the laboratory for analysis.

The results from the suspects' samples show the following:

1 Suspect A is a woman with brown hair and blood type B
2 Suspect B is a man with red hair and blood type A
3 Suspect C is a man with black hair and blood type B
4 Suspect D is a man with blonde hair and blood type B

Phase 2 Interrogation of contexts

1. Which of the four suspects do you think is the prime murder suspect? Why?
2. Is the information sufficient to determine the murderer?
3. If not, what can you do to confirm or reject the evidence against the suspected murder?
4. Is it possible for another person to have exactly the same evidence as that of the murderer? Explain.
5. Is there any other information which could be used to determine the murderer?

Phase 3 Introduction of content

- Chromosome structure
- Protein synthesis
- Blood-typing
- Finger-printing
- DNA testing
- Permanent and changeable characteristics.

Phase 4 Linkage of content and context

Learners to use the information learned to answer the questions from the second phase.

1 Are there any differences between your initial and current answers?
2 What new information has been useful in clarifying or answering the questions?
3 What is your opinion on the use of forensic science to judge people?
4 Do you have any questions that could not be answered using the information provided in phase 3?

Phase 5 Assessment of learning

1. The study and application of scientific facts and techniques to solve crimes is called

   _____

2. A bank is robbed overnight and the security guard at the bank is tied up by the criminals. What sorts of things would a forensic expert look for or investigate as evidence for convicting the criminals?
3. A person was accused of assaulting another and causing grievous bodily harm. The victim's blood type was B, and the suspect was found with a lot of blood on his clothes, which was also type B.
   (i) What conclusions can you draw from this case?
   (ii) What forensic evidence would you need to convict the perpetrator?

Lesson example 6

PRACTICAL 5 CLONING OF ORGANISMS

(Adapted from: Salters-Nuffield Advanced Biology, 2005).

INTRODUCTION

New advances in genetics have resulted in the ability to produce several identical organisms using the genes of a single organism. All the organisms made from the donor organism have exactly the same characteristics as the donor organism. The production of identical organisms, tissues or cells that are derived from a single donor organism is called cloning. In this experiment we shall simulate the cloning of animals.

OBJECTIVES

- To demonstrate the cloning of animals
- To show how organisms with desired characteristics can be produced using genetic engineering.

CONTEXT

Mr Van Wyk is a farmer who produces sheep for sale. Some of Mr Van Wyk's sheep have better fur quality than others, and such sheep sell at a higher price. Mr Van Wyk wants to have more of the sheep with quality fur so that he could make more money. He asks you, as a professional genetics scientist, to help him produce more of the sheep with good fur using genes from the desired sheep. In this experiment, you are required to follow the procedure below, to simulate the process of cloning animals using model organisms called woolbes, made from cotton wool and other materials.

SAFETY WARNING

Learners should **NOT** in any circumstance taste any of the materials used in this experiment, as safety and hygiene conditions cannot be guaranteed in the laboratory.

REQUIREMENTS PER GROUP

	Materials	Quantity	
1.	Envelops with chromosomes sets	2	(surrogate and desired sets)
2.	Big balls of cotton wool	10	(Body segments plus head) x2
3.	Small balls of cotton wool	4	(for the breasts)
4.	A yellow bead and a silver heart shape		(for small and big noses)
5.	big silver and small red star shapes	2	pairs (for big and small ears)
6.	Pieces of pipe cleaners	20	(antennae, legs, breasts, tail)
7.	Eye shapes	2	pairs (for big and small eyes)
8.	Toothpicks	4	(for joining the body segments)
9.	Glue	1	tube

Note

(i) All materials **MUST** be kept by the educator at the front of the class.
(ii) Learners should collect **ONLY** the specific shapes and colours of materials required for the construction of the Woolbes as determined by the selected genotypes.
(iii) The surrogate and desired Woolbe chromosome sets should be of different colours, and they should not be mixed.
(iv) The chromosomes **must be cut** along the longitudinal lines, to separate them, before putting them into the envelopes.

Instructions

You are provided with two envelopes containing the genotypes of two Woolbes. One envelope contains the genotype of a surrogate Woolbe, and the other contains the genotype of a desired Woolbe. Each set of genotypes consists of eighteen (9 pairs) chromosomes, coding for nine different characteristics. The characteristics of the surrogate and desired Woolbes, which are based on these chromosomes, are shown in the figures below.

Figure 5.1 Characteristics of surrogate Woolbe

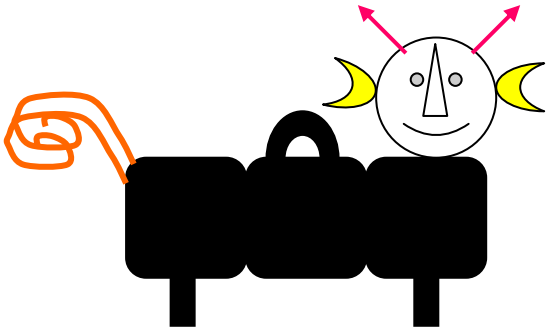
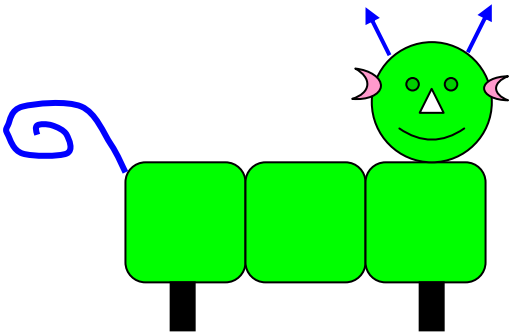


Figure 5.2 Characteristics of desired Woolbe



CONSTRUCTION OF SURROGATE, DESIRED AND CLONED WOOLBES

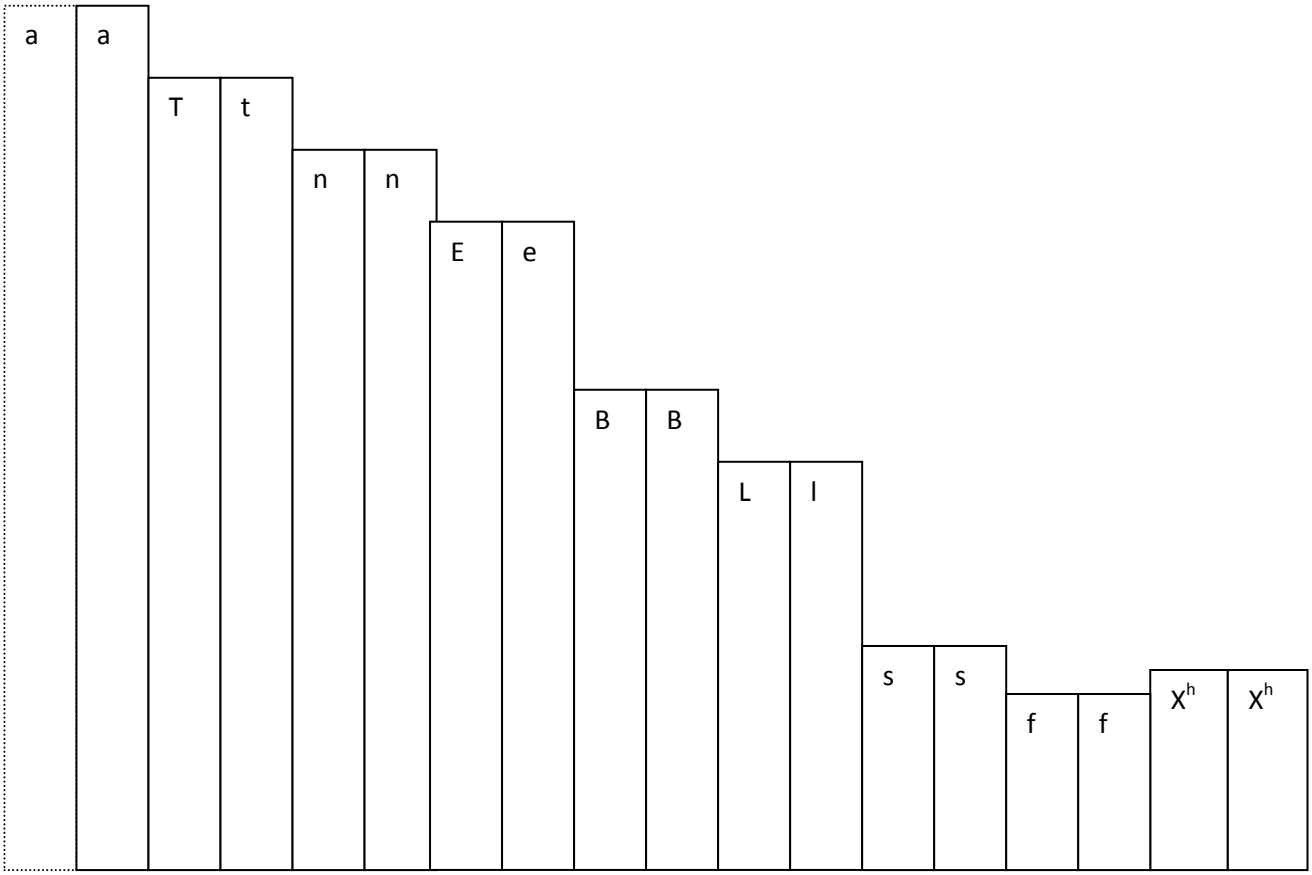
Construct the surrogate, desired and cloned Woolbes according to the following procedure.

INSTRUCTIONS

Stage one: Construction of the surrogate Woolbe.

1. Use the genotypes provided in figure 5.3, and the genetic information in table 5.1 below, to determine the genotype (genetic composition) and phenotype (characteristics) of the surrogate Woolbe, then complete table 5.2.

Figure 5.3 Genotype of surrogate Woolbe



The following table shows the genetic code for determining the characteristics of the Woolbes from their genotypes.

Table 5.1 Genetic code for Woolbe characteristics

Trait	Letter	Genotype and phenotype of Woolbes		
Antennae	**A**	AA = Red	Aa = White	aa = Blue
Tail	**T**	TT = Yellow	Tt = Yellow	tt = Orange
Forked tail	**F**	FF = normal tail	Ff = normal tail	ff = forked tail
Nose	**N**	NN = Big nose	Nn = Big nose	nn = small nose
Sex / Hump	**X & Y with H**	$X^H X^H$ or $X^H X^h$ = female without a hump	$X^H Y$ = male without a hump	$X^h Y$ or $X^h X^h$ = male or female with a hump
Body segments	**B**	BB = Green	Bb = Green	bb = Black
Eyes	**E**	EE = Big	Ee = Big	ee = small
Legs	**L**	LL = Black (Grey)	Ll = Black (Grey)	ll = green
Ear size	**S**	SS = Big (Gold)	Ss = Big (Gold)	ss = small (Red)

Table 5.2 Genotypes and phenotypes of surrogate woolbe

Trait	Genotype	Characteristic (phenotype) of surrogate Woolbe
Antennae		
Tail		
Forked tail		
Nose		
Sex/Hump		
Body segments		
Eyes		
Legs		
Ear size		

Using the information from table 5.2, construct the surrogate woolbe as shown in Figure 5.1 above.

Note Use **ONLY** the appropriate shapes and colours according to the characteristics (phenotype) of the Woolbe under construction.

Procedure for constructing woolbes

1. Stick three balls of Cotton Wool together using a toothpick, to represent body segments.
2. Using another toothpick, stick another ball of cotton wool on top of the third ball of cotton wool, to symbolize the head.
3. Cut three pieces of about 5 cm of a pipe cleaner. For each piece, curve one end, and trim (remove the wool) from the other end, then stick the trimmed ends of two of the pipe cleaners on the head, to indicate the antennae.
4. Stick the trimmed end of the third one on the last body segment, to serve as a tail.
5. For a forked tail (genotype of ff), twist trimmed ends of two pieces of pipe cleaner together, but leave the curved ends separate, then stick the twisted trimmed ends on the last body segment – the forked tail.
6. Cut four pieces of about 5 cm of a pipe cleaner. For each piece, bend one end to form a foot, and trim the other end (remove the wool). Insert two of the pipe cleaners into the lower part of the first segment of the body, and the other two pipe cleaners on the third segment of the body, to form the legs of the woolbe.
7. Use glue to stick two big or small eyes (depending on the genotype) on the front part of the head.
8. Use glue to stick a big or small nose (according to the genotype) just below the eyes.
9. Use glue to stick two small or big ears on either side of the head.
10. If you have a female genotype (XX), stick two small cotton balls on the lower side of the middle body segment, to represent the breasts.

Stage two: Formation of surrogate Woolbes'egg cell and extraction of nucleus

1. Turn the chromosome cards upside down, so that you do not see the letters on the cards.
2. Place the chromosomes of the surrogate Woolbe in pairs according to their length (diploid set).
3. Randomly select one chromosome from each pair (half of the chromosomes found in the diploid cell), and put them in an envelope, to form the genetic set of chromosomes found in her egg. (The envelope represents the egg cell).
4. Suck (remove) the genetic materials (nucleus) from the surrogate Woolbe's egg (the envelope), leaving the cell without any genetic materials.

Stage three: Construction of desired Woolbe

1, Use the genotype provided in figure 5.4 below and information from table 5.1 above, to determine the genotypes and phenotypes of the desired woolbe and complete table 5.3.

Figure 5.4 Genotype of desired Woolbe

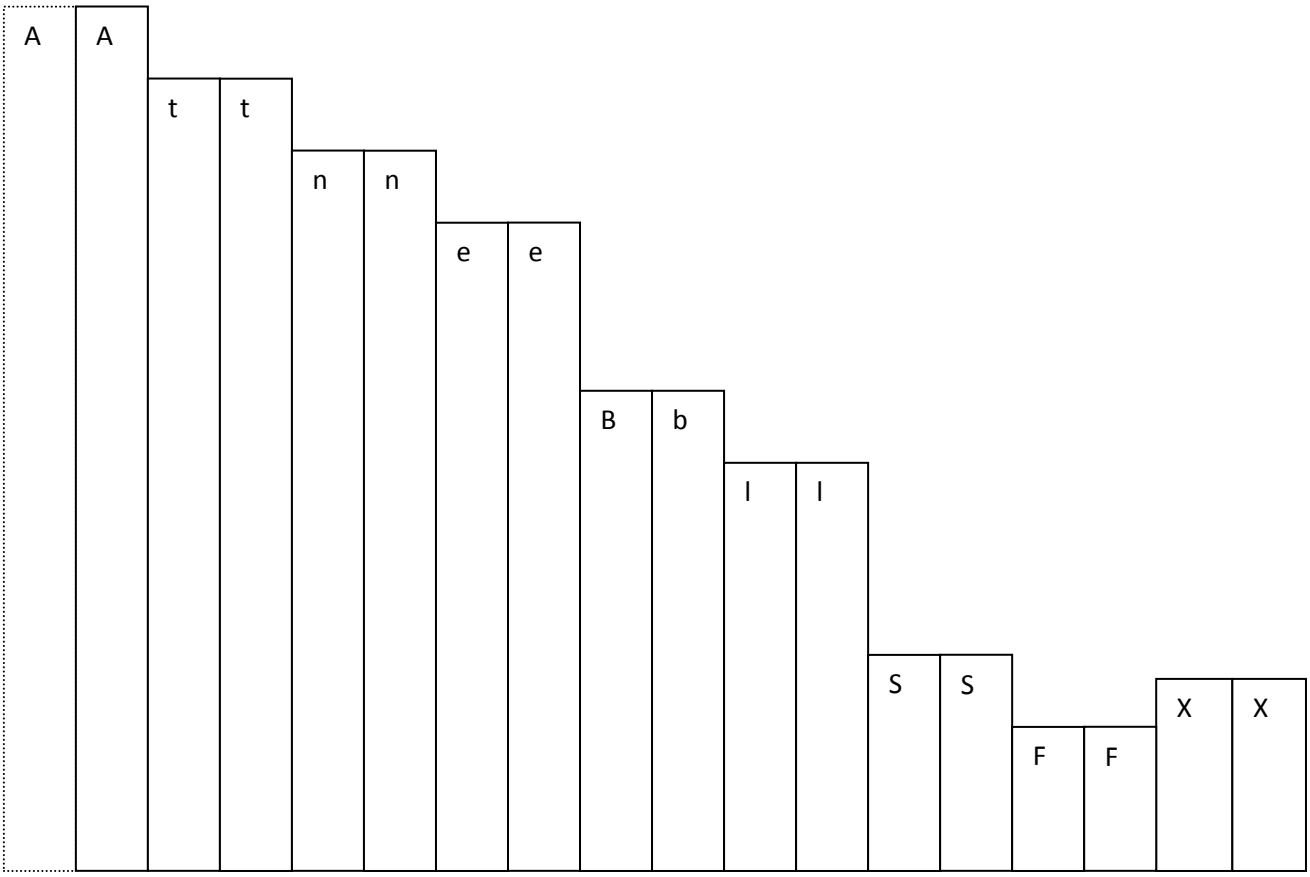


Table 5.3 Genotypes and phenotypes of desired woolbe

Trait	Genotype	Characteristic (phenotype) of desired Woolbe
Antennae		
Tail		
Forked tail		
Nose		
Sex/Hump		
Body segments		
Eyes		
Legs		
Ear size		

Using the phenotypes shown in table 5.3, construct the desired Woolbe as shown in Figure 5.2.

Stage four: Formation of the cloned Woolbe

1. Open the envelope containing the chromosomes of the desired Woolbe.
2. Suck out the diploid set of genetic materials(remove all the chromosomes) from the cell (envelope) taken from the desired Woolbe's body.
3. Inject (put) this genetic material from the desired Woolbe into the empty egg cell (empty envelope) of the surrogate Woolbe, created under stage 2. **This action results in an embryo whose genetic material was came from the desired Woolbe.**
4. Using the genetic materials from the embryo's cell (figure 5.4), and the information in Table 5.1, to compete table 5.4. Use the information from table 5.4 to construct the cloned Woolbe, as shown in Figure 5.5 below.

Figure 5.5 Characteristics (phenotypes) of the cloned baby Woolbes

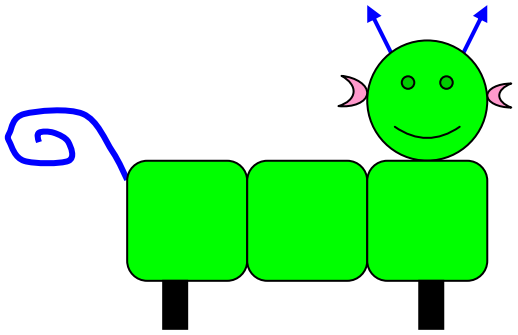


Table 5.4 Genotypes and phenotypes of cloned woolbe

Trait	Genotype	Characteristic (phenotype) of cloned Woolbe
Antennae		
Tail		
Forked tail		
Nose		
Sex/Hump		
Body segments		
Eyes		
Legs		
Ear size		

Questions

Place your cloned baby Woolbes together in a nursery and answer the following questions.

1. Do all the cloned Woolbes show features of a typical Woolbe? Explain.
2. Do the cloned woolbes have characteristics from both the surrogate and the desire woolbe?

3. Are the cloned Woolbes identical (similar to each other in every way) or are their some differences? Explain.
4. Are there any characteristics present in the cloned Woolbes that do not appear in the desired Woolbe? Explain.
5. Are there any characteristics in the cloned Woolbes which could be considered abnormal? Explain.
6. Were the cloned Woolbes formed from genes coming from two parents? Explain.
7. Is there any difference in the sex(es) of the cloned baby Woolbes? Explain.

REFERENCE

University of York Science Education group (2005). Salters-Nuffield Advanced Biology (SNAB). New York, UK.

Appendix VII: Genetics Content Knowledge Test (GCKT)

Learner code ☐

Age ☐

Grade ☐

Gender ☐

DURATION: 1 Hour

TOTAL MARKS: 55

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. **Answer ALL the questions.**
2. **Write ALL the answers in the spaces provided for each question.**
3. **Present your answers according to the instructions of each question.**
4. **ONLY draw diagrams or flow charts when asked to do so.**
5. **Non-programmable calculators, protractors and compasses may be used**
6. **Write neatly and legibly.**

SECTION A [9]

QUESTION 1 [5]

For the following questions, various options are provided as possible answers. Choose the correct answer by marking a cross on the letter that represents the correct answer.

For example: Which of the following is a province found in South Africa?

A. Pretoria
B. Cape Town
X Gauteng
D. Polokwane

Answer the following questions in the same way.

1.1 Down's syndrome occurs when

A. a male sex cell undergoes mitosis.
B. every cell of an organism has an extra pair of chromosomes.
C. all somatic cells have an extra chromosome.
D. a female sex cell undergoes mitosis.

1.2 Indicate which one of the following crosses will result in a ratio of 50% homozygous black to 50% heterozygous.

A. Bb X bb
B. BB X bb
C. BB X Bb
D. Bb X Bb

1.3 The possible genotypes for an individual with blood group A are

A. I^AI^A; I^AI^B
B. I^AI^A; ii
C. I^Ai; I^Bi
D. I^AI^A; I^Ai

1.4 The phenotypic ratio in the offspring resulting from the cross Tt x Tt is:

A. 1:2:1.
B. 3:1.
C. 1:1.
D. 9:3:3:1.

1.5 A father has blood type B and a mother has blood type O. They have three children of their own and one adopted child. Sipho has blood type B, Thandiwe has blood type AB. Thuli has blood type O and Bongiwe has blood type B. Which child is adopted?

A. Sipho
B. Thandiwe
C. Thuli
D. Bongiwe

QUESTION 2 [4]

Give the correct biological term for each of the following descriptions in the spaces provided.

2.1 Genes in the same position on homologous chromosomes (1)

_____

2.2 A pair of identical chromosomes found in diploid cells (1)

_____

2.3 A change in the chemical structure of a gene (1)

_____

2.4 An individual with alleles for a dominant characteristic on both chromosomes of a homologous pair (1)

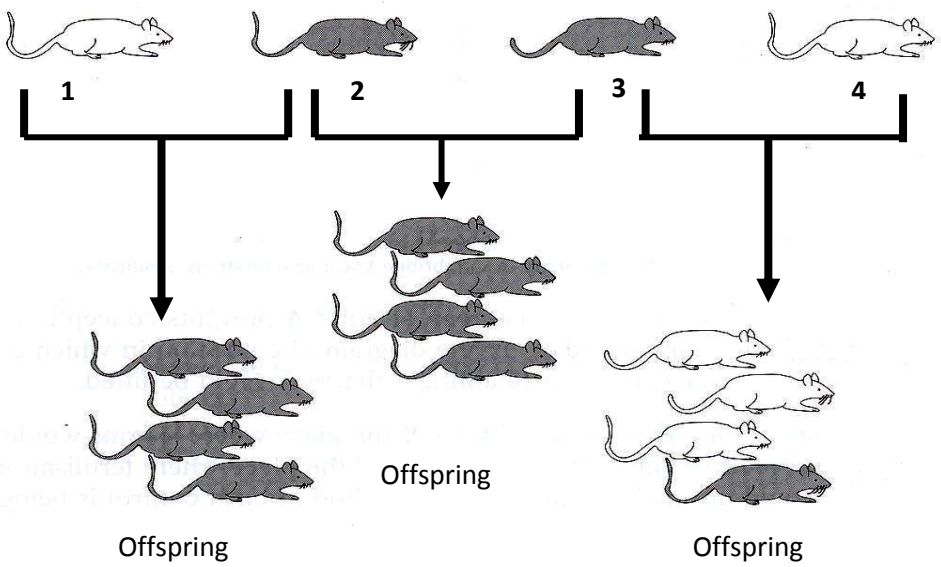
_____

SECTION B [46]

Answer all the following questions in the space provided for each question. Show your working where necessary.

QUESTION 3 [6]

Study the diagram below, which shows some breeding experiments on mice. A single pair of alleles showing complete dominance controls coat colour (white or grey) in these mice.



Results of breeding experiments

3.1 If mouse **1** is a female, state the sex chromosomes that would be present in the gametes of parent mouse **2** and mouse **3** respectively. (2)
Answer: Parent mouse 2 _____. Parent mouse 3_____

3.2 If mice **3** and **4** had a second set of offspring, what is the percentage chance that the first mouse born would be female? (1)
Answer: _____

3.3 Which of the parent mice (**1, 2, 3** or **4**) is likely to be homozygous dominant for coat colour? (1)
Answer: _____

3.4 State why mouse **3** can only be heterozygous for coat colour. (2)
Answer:_____

QUESTION 4 [11]

Read the passage below and answer the questions that follow.

GENETICALLY MODIFIED PIG BRED WITH 'GOOD FAT'

Scientists in South Africa have produced genetically modified pigs with fat containing omega-3 fatty acids. These fatty acids, which are usually found in certain types of fish, are thought to be responsible for a number of benefits, from combating heart disease to improving intelligence. Researchers from the University of Pretoria's School of Medicine created piglets capable of converting less useful omega-6 fatty acids into omega-3 fatty acids. They implanted 1 800 embryos into 14 female pigs. Ten live offspring, which were able to make high levels of omega-3 fatty acids, were born.

[Adapted from: *Cape Argus*, 27 March 2006]

4.1 What percentage success did the scientists have with the implanted embryos in forming a clone of pigs capable of producing omega-3 fatty acids? Show ALL working. (3)

Answer: _____

4.2 To produce genetically modified pigs, the gene that produces omega-3 fatty acids is inserted into the pig embryos. Describe the steps in forming, and introducing many copies of the desirable gene (using bacteria) into the pig embryos. (4)

Answer:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

4.3 Give TWO reasons why:

(a). Some people may support the use of genetically modified pigs to produce omega-3 fatty acids (2)

Answer

(i) _____

(ii) _____

(b) Some people may be against the use of genetically modified pigs to produce omega-3 fatty acids. (2)

Answer

(i) _____

(ii) _____

QUESTION 5 [12]

A body of a young woman was found on an open plot. She had been allegedly assaulted and murdered. DNA specimens were taken at the scene.

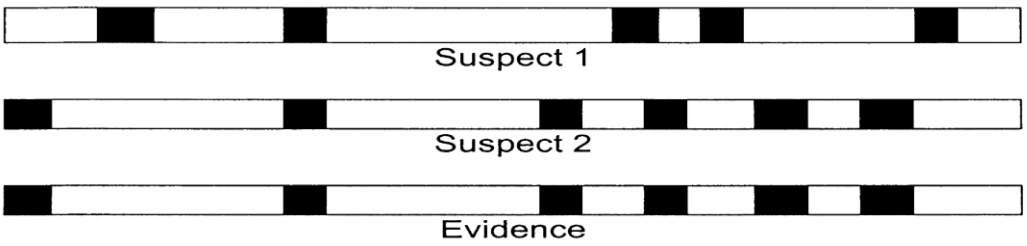
5.1 What is the purpose of taking DNA specimens at the scene? (2)

Answer: _____

5.2 What other purpose, (not those mentioned in question 5.1) can DNA fingerprinting also be used for? (1)

Answer _____

The DNA fingerprints below were used as evidence in a court case in order to convict the crime suspect. A fraction of DNA finger-print was derived from dry blood that was found on the victim's belt (with which she was strangled). Study the DNA finger-prints and answer the questions that follow.



5.3 Which suspect is most probably the murderer? (1)

Answer: _____

5.4 Give a reason for your answer to question 5.3. (1)

Answer:_____
_____

5.5 Is there any way in which the suspect can prove his innocence? Explain (3)

Answer:_____
_____
_____

5.6 In what way do you think the forensic team can prove this claim wrong? (2)

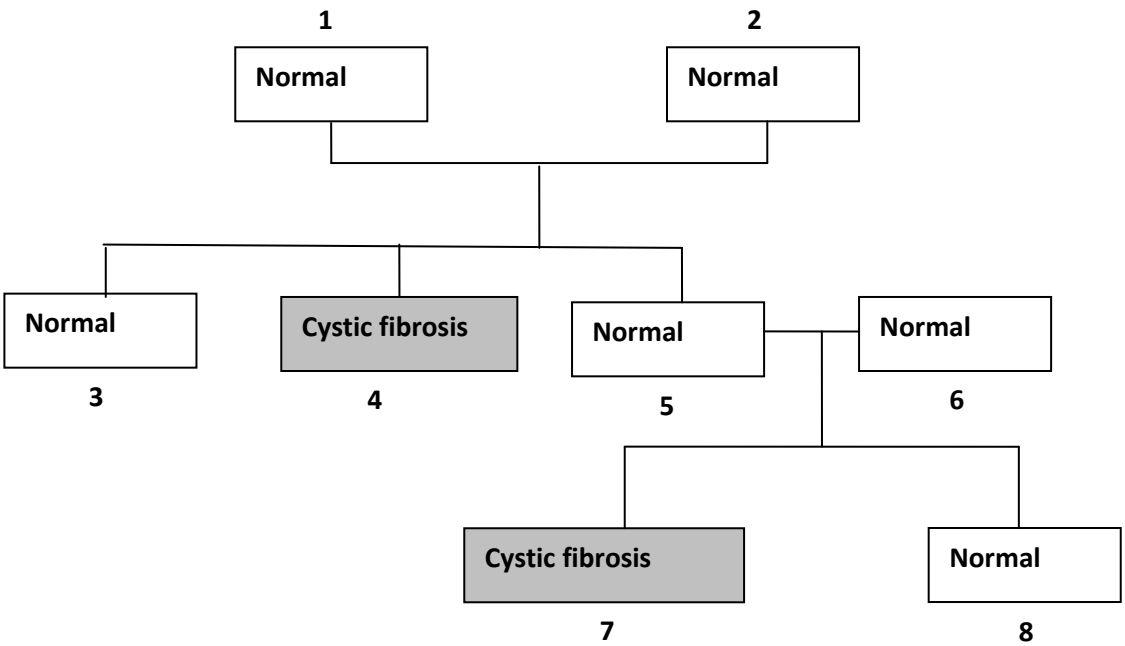
Answer:_____
_____

5.7 If one of the suspects refused to give his DNA for testing, should he be forced to do so? Explain. (2)

Answer:_____
_____
_____

QUESTION 6 [12]

The diagram below shows a family tree for cystic fibrosis. This condition is produced by a recessive allele, f, while the normal condition is controlled by the dominant allele, F.



6.1 What are the possible genotypes of individuals 1, 4, and 5 respectively? (3)

Answer:

_____

6.2 Briefly explain TWO symptoms of cystic fibrosis. (2)

(i) Answer:_____

(iii) Answer:_____

6.3 If individual 8 is heterozygous, what are the chances of individuals 7 and 8 having a NORMAL child? Show this by means of a Punnet diagram. (5)

Answer:_____

6.4 Is cystic fibrosis a sex-linked disease? Briefly explain your answer.

Answer:_____

_____

_____

_____

_____

_____

_____

_____

_____

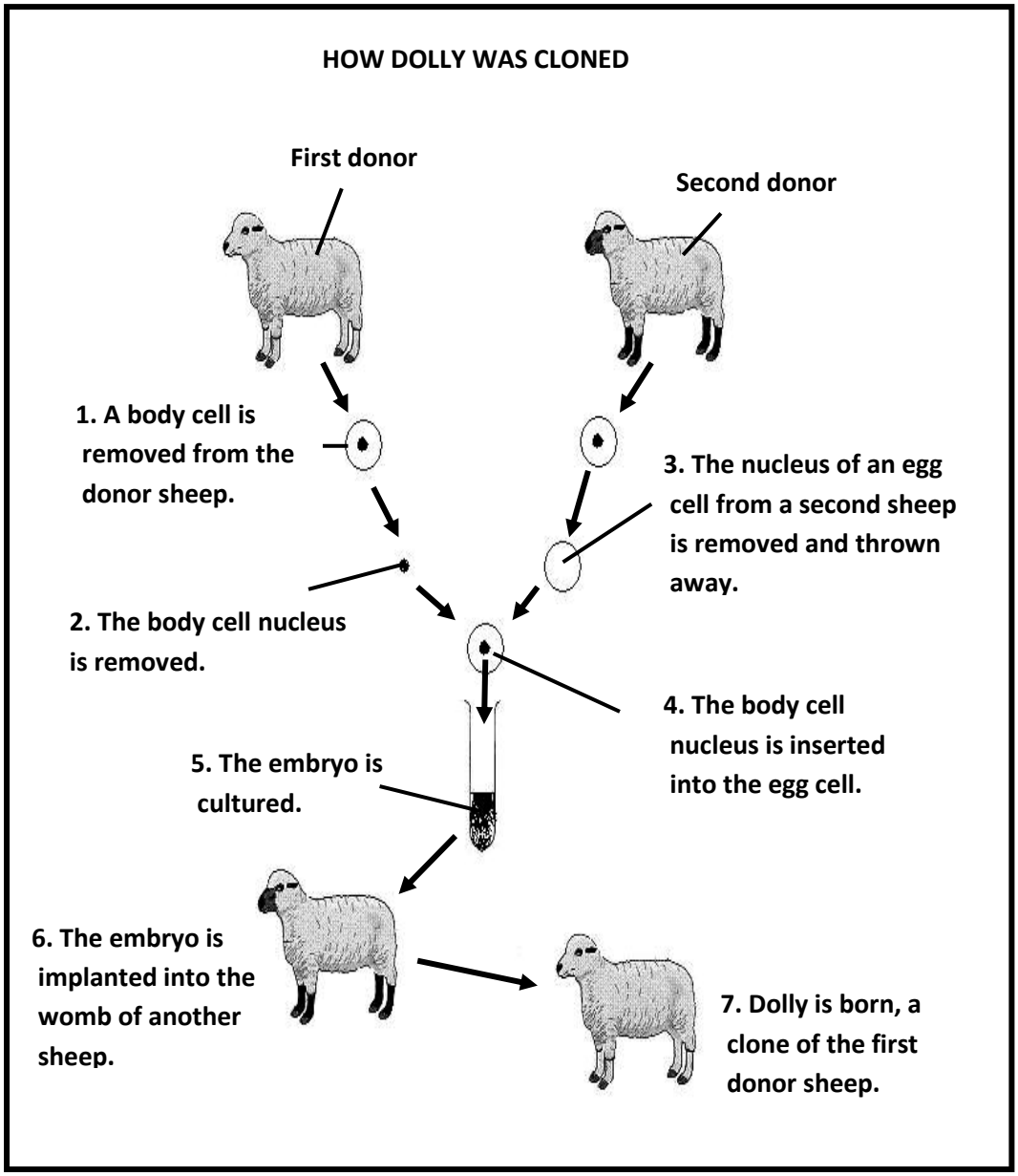
_____

_____

(2)

QUESTION 7 [5]

Study the diagram below that shows the cloning of a sheep named Dolly.



7.1 Why was it necessary to remove the nucleus from the egg cell of the second donor before the sheep could be cloned? (1)

Answer:_____

7.2 Would Dolly have any characteristics of the second donor sheep? (1)

Answer: _____

7.3 Explain your answer to **question. 7.2** (2)

Answer:_____
_____
_____
_____

7.4 Number 5 on the diagram states that 'the embryo is cultured'. Through which process of cell division does the embryo develop? (1)

Answer: _____

TOTAL MARKS **[55]**

THE END

****

MEMORANDUM FOR GENETICS CONTENT KNOWLEDGE- (GCKT)

SECTION A [9]

QUESTION 1 [5]

For the following questions, various options are provided as possible answers. Choose the correct answer by putting a cross on the letter that represents the correct answer.

For example: Which of the following is a province found in South Africa?

E. Pretoria
F. Capetown
☒ Gauteng
H. Polokwane

Answer the following questions in the same way.

1.1 Down's syndrome occurs when

A. a male sex cell undergoes mitosis.
B. every cell of an organism has an extra pair of chromosomes.
C. <u>all somatic cells have an extra chromosome.</u>
D. a female sex cell undergoes mitosis.

1.2 Indicate which one of the following crosses will result in a ratio of 50% homozygous black to 50% heterozygous.

A. <u>Bb X bb</u>
B. BB X bb
C. BB X Bb
D. Bb X Bb

1.3 The possible genotypes for an individual with blood group A are

A. I^AI^A; I^AI^B
B. I^AI^A; ii
C. I^Ai; I^Bi
D. <u>I^AI^A; I^Ai</u>

1.4 The phenotypic ratio in the offspring resulting from the cross Tt x Tt is:

A. 1:2:1.
B. <u>3:1.</u>
C. 1:1.
D. 9:3:3:1.

1.5 A father has blood type B and a mother has blood type O. They have three children of their own and one adopted child. Sipho has blood type B, Thandiwe has blood type AB. Thuli has blood type O and Bongiwe has blood type B. Which child is adopted?

A. Sipho
B. Thandiwe
C. Thuli
D. Bongiwe

QUESTION 2 [4]

Give the correct biological term for each of the following descriptions, in the spaces provided.

2.1 Genes in the same position on homologous chromosomes (1)
_____Alleles_____

2.2 A pair of identical chromosomes found in diploid cells (1)
____Homologous pair of chromosomes_____

2.3 A change in the chemical structure of a gene. (1)
____Mutation_____

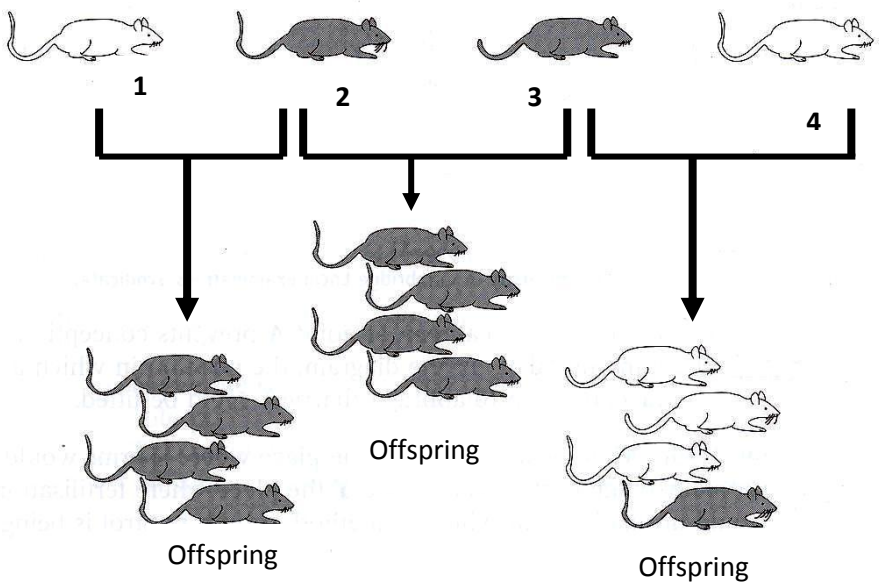
2.4 An individual with alleles for a dominant characteristic on both chromosomes of a homologous pair.
___Homozygote/Homozygous_____ (1)
[4]

SECTION B

Answer all the following questions in the space provided for each question. Show your working where necessary.

QUESTION 3

Study the diagram below, that shows some breeding experiments on mice. A single pair of alleles showing complete dominance controls coat colour (white or grey) in these mice.



Results of breeding experiments

3.1 If mouse **1** is a female, state the sex chromosomes that would be present in the gametes of parent mouse **2** and mouse **3** respectively. (2)

Answer: Parent mouse 2 __**XY**__. Parent mouse 3___**XX**___

3.2 If mice **3** and **4** had a second set of offspring, what is the percentage chance that the first mouse born would be female? (1)

	X	Y
X	XX	XY
X	XX	XY

Answer: _____**50%**_____

3.3 Which of the parent mice (**1, 2, 3** or **4**) is likely to be homozygous dominant for coat colour? (1)

	C	c
C	CC	Cc
C	CC	Cc

Answer: _____**Mouse 2**_____

3.4 State why mouse **3** can only be heterozygous for coat colour. (2)

Answer: **A cross between mouse 3 and mouse 4 produced offspring with white/recessive coat colour√, and white/recessive coat colour only shows up when both parents have at least one recessive gene√** __

[6]

QUESTION 4

Read the passage below and answer the questions that follow.

GENETICALLY MODIFIED PIG BRED WITH 'GOOD FAT'

Scientists in South Africa have produced genetically modified pigs with fat containing omega-3 fatty acids. These fatty acids, which are usually found in certain types of fish, are thought to be responsible for a number of benefits, from combating heart disease to improving intelligence. Researchers from the University of Pretoria's School of Medicine created piglets capable of converting less useful omega-6 fatty acids into omega-3 fatty acids. They implanted 1 800 embryos into 14 female pigs. Ten live offspring, which were able to make high levels of omega-3 fatty-acids were born. [Adapted from: *Cape Argus*, 27 March 2006]

4.1 What percentage success did the scientists have with the implanted embryos in forming a clone of pigs capable of producing omega-3 fatty acids? Show ALL working. (3)

$$\frac{10\ √\ X\ 100√}{1800}$$

= 0.55%√

Answer: _____

4.2 To produce genetically modified pigs, the gene that produces omega-3 fatty acids is inserted into the pig embryos. Describe the steps in forming and introducing many copies of the desirable gene (using bacteria), into the pig embryos. (4)

Answer: **The gene responsible for producing omega 3 is located √**
In DNA of salomon /fresh mackerel/ tuna √
This gene is cut/removed from the donor organism √
It is inserted into the plasmid of a bacterium √
Recipient bacterium replicates to form many copies of the gene √
These genes are inserted into the cells of the zygote/embryo of a pig/organism.(Any four correct responses)

4.3 Give TWO reasons why

(a). Some people may support the use of genetically modified pigs to produce omega-3 fatty acids (2)

Answer **(i)** **Healthier for humans to eat √, combat heart disease √**

(ii) **Mass production of healthy fats √**
Improves intelligence

(b) Some people may be against the use of genetically modified pigs to produce omega-3 fatty acids. (2)

Answer **(i)** **Cultural/religious objections to eat meat from pigs/pork √**

(ii) **Very low success rates √**
Expensive procedure √
No value for vegetarians √
Objections to eating genetically modified foods √ **[11]**

QUESTION 5

A body of a young woman was found on an open plot. She had been allegedly assaulted and murdered. DNA specimens were taken at the scene.

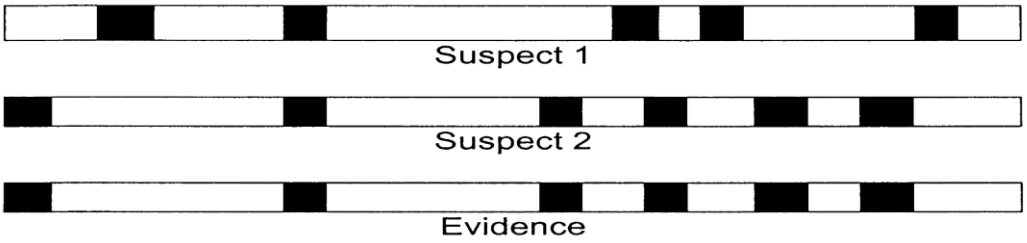
5.1 What is the purpose of taking DNA specimens at the scene? (2)

Answer: **To identify the victim √ / To identify the murderer/perpetrator/rapist √**

5.2.1 What other purpose, (not those mentioned in question 5.1) can DNA fingerprinting also be used for? (1)

Answer: **To determine paternity / paternity tests**

The DNA fingerprints below were used as evidence in a court case in order to convict the crime suspect. A fraction of a DNA finger-print was derived from dry blood that was found on the victim's belt (with which she was strangled). Study the DNA finger-prints and answer the questions that follow.



5.3 Which suspect is most probably the murderer? (1)

Answer: **Suspect 2 √**

5.4 Give a reason for your answer to question 7.3. (1)

Answer: **The bar code pattern of suspect 2 correlates exactly with that of the documentary evidence √**

5.5 Is there any way in which the suspect can prove his innocence? Explain (3)

Answer: **Yes √, He/she can argue that the dry blood came from the victim himself.√√**

5.6 In which way do you think the forensic team can prove this claim wrong? (2)

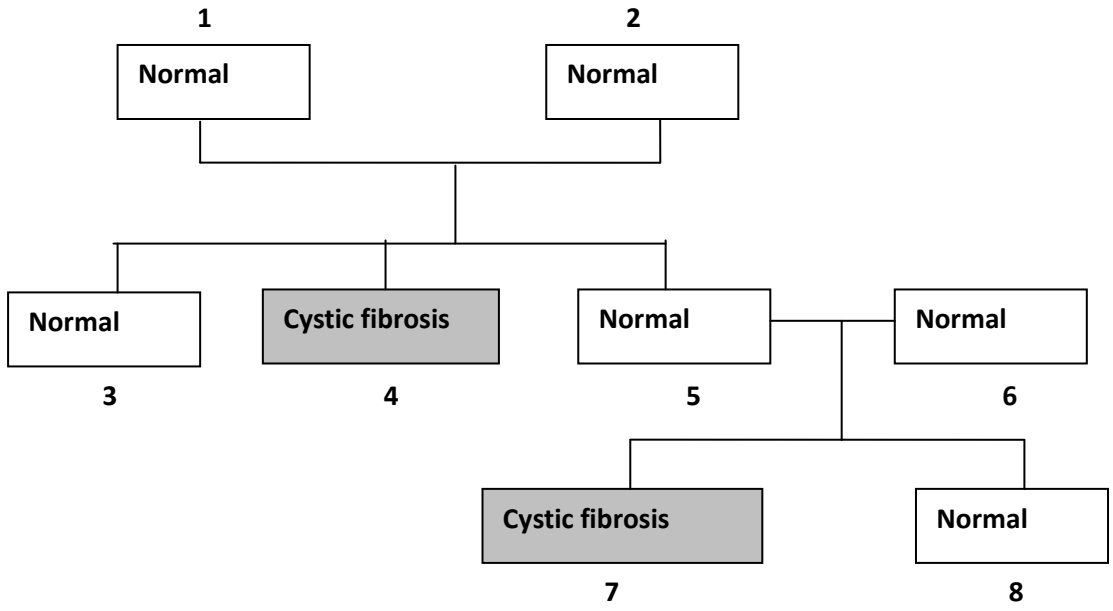
Answer: **The forensic team should have made a DNA print of the victim's DNA√, in order to compare it with the evidence √**

5.7 If one of the suspects refused to give his DNA for testing, should he be forced to do so? Explain. (2)

Answer: _**Yes √, If he/she knows he/she is innocent, he/she would not have a problem giving his DNA, so the suspect is most probably guilty, and should therefore be forced to give his/her DNA sample √. By committing murder, you take away another person's life, and therefore surrender your own rights to privacy√.**_OR **No √, His right to privacy should not be violated √, He cannot be forced to do anything against his will √. [12]**

QUESTION 6

The diagram below shows a family tree for cystic fibrosis. This condition is produced by a recessive allele, f, while the normal condition is controlled by the dominant allele, F.



6.1 What are the possible genotypes of individuals 1, 4, and 5 respectively? (3)
Answer: **1 – Ff √; 4 – ff √; 5 – Ff √.**

6.2 Briefly explain TWO symptoms of cystic fibrosis. (2)
(i) Answer: _**Body produces an abnormally thick sticky mucus √.**
- that accumulates in the lungs √.
(ii) Answer:_**Certain enzymes are not produced √**
leading to digestive problems √
Produce sweat with high salt content / salty sweat √
Low immunity √ (Any two correct responses)**.**

6.3 If individual 8 is heterozygous, what are the chances of individuals 7 and 8 of having a NORMAL child? Show this by means of a Punnett diagram. (5)

	f	**f**√
√**F**	Ff	Ff √
f	ff	ff √

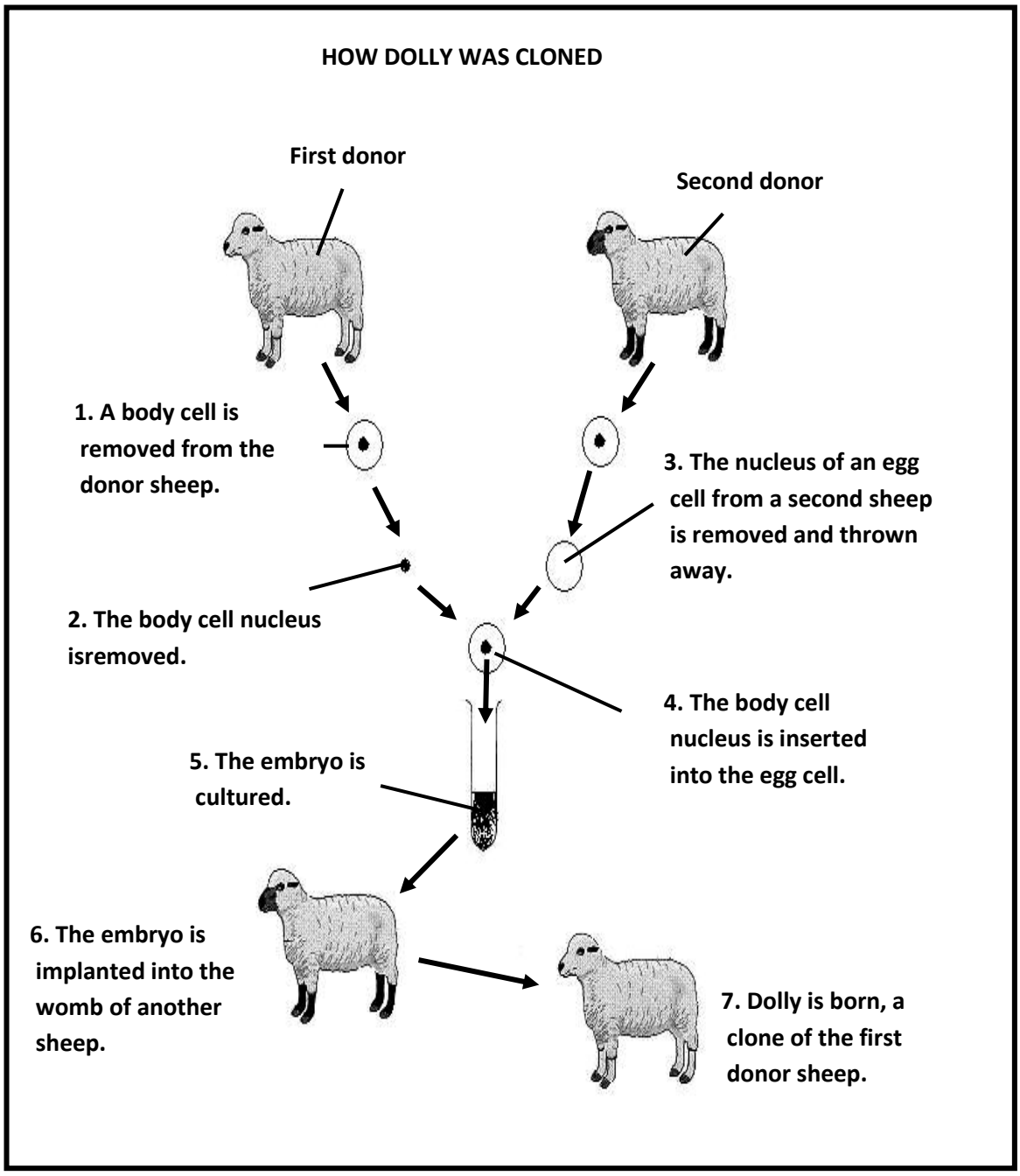
Answer**:**_____**= 50%** _√ **Chance of Cystic fibrosis**_____

6.4 Is cystic fibrosis a sex-linked disease? Briefly explain your answer. (2)
Answer: **No √, Both males and females can get the disease √.**

[12]

QUESTION 7

Study the diagram below that shows the cloning of a sheep named Dolly.



7.1 Why was it necessary to remove the nucleus from the egg cell of the second donor before the sheep could be cloned? (1)

Answer: **To insert the DNA / nucleus √ of the sheep that you want to clone √**

7.2 Would Dolly have any characteristics of the second donor sheep? (1)
Answer: **No √**

7.3 Explain your answer to **question 10.2** (2)

Answer: **Dolly will have exactly the same DNA as the first donor sheep √, because the DNA of the second donor sheep was removed √ and replaced.**

7.4 Number 5 on the diagram states that 'the embryo is cultured'. Through which process of cell division does the embryo develop? (1)

Answer: **Mitosis√,**

[5]

TOTAL MARKS **[55]**

Appendix VIII: Test of Science Inquiry Skills (TOSIS)

Learner code ☐

Age ☐

Grade ☐

Gender ☐

DURATION: 30 Minutes

TOTAL MARKS: 20

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. **Answer ALL the questions.**
2. **Write ALL the answers in the spaces provided for each question.**
3. **Present your answers according to the instructions of each question.**
4. **ONLY draw diagrams or flow charts when asked to do so.**
5. **Non-programmable calculators, protractors and compasses may be used.**
6. **Write neatly and legibly.**

1. Read the following passage carefully and choose the best answer from the options given after each question, by putting a cross [X] on the letter that represents your choice. After making your choice, give a reason(s) for choosing the option.

Mpho discovered that his bread was covered with bread mould (fungi that grows on bread). He wondered whether temperature had anything to do with the presence of bread mould on his bread. He decided to grow bread mould in nine similar containers with temperature regulators. Three containers were kept at 0°c, three were kept at 90°c, and three were kept at room temperature (about 27°c). He put the same amount of bread, and bread mould in each of the containers and kept all of them in the same cupboard. Mpho measured the amount of the bread mould in each container after four days.

1.1 In this experiment Mpho was trying to test whether _____

A. bread mould will cover the bread in the three containers, after four days.
B. growth of bread mould is affected by the temperature of the environment.
C. the amount of bread mould is determined by the amount of bread available.
D. the type of container used determines the amount of bread mould produced.

Give a reason for your choice.

_____
_____

1.2 The factor that was expected to change in this experiment was:

A. the amount of the bread mould in each container.
B. the amount of bread in each container
C. the temperature of each container
D. the number of containers at each temperature

Give a reason for your choice

_____
_____

1.3 Which factor was changed (manipulated) in this experiment?

A. The number of containers at each temperature
B. The amount of bread in each container
C. The presence of bread mould in the containers
D. The temperature of the containers

Give a reason for your choice

_____
_____

2. Read the following passage adapted from the National Geographic news. Retrieved on 32/02/2010, from: http://en.wikipedia.org/wiki/Colony_collapse_disorder

Then answer the questions that follow.

Mystery Bee Disappearances

Without a trace, something is causing bees to disappear (vanish) by the thousands. A phenomenon called Colony Collapse Disorder (CCD), in which worker bees from a beehive abruptly disappear is affecting bee colonies in the United States. The cause(s) of the Colony Collapse disorder are not yet fully understood, although many authorities think that the problem is caused by biotic factors such as *Varroa* mites and insect diseases. Other proposed causes include environmental change-related stresses, malnutrition, pesticide use, and migratory beekeeping. More speculative possibilities have included both cell phone radiation and genetically modified (GM) crops with pest control characteristics. Up to now, no evidence exists for any of these suggestions (assertions). It has also been suggested that it may be due to a combination of many factors, and that no single factor is the cause.

Colony collapse is economically significant because many agricultural crops, worldwide, are pollinated by bees. For example an estimated 14 billion U.S. dollars in agricultural crops in the United States is dependent on bee pollination. A lot of people think that honeybees are only important for the honey they produce, but much, much more important are their pollination services.

Imagine that you are a scientist who is interested in knowing the cause(s) of the bee colony collapse disorder. You decide to investigate the effect of pesticides on the disappearance of the bees.

2.1 Which of the following ideas would you test in your investigation? (Put a cross [☒] on the letter that represents your choice).

A. Bees are disappearing by the thousands in Colony Collapse Disorder.
B. Understanding the different causes of the Colony Collapse Disorder.
C. Stresses, malnutrition, pesticides, migratory beekeeping, cell phone radiation, and genetically modified crops are the causes of the Colony Collapse Disorder.
D. Pesticides cause Colony Collapse Disorder.

2.2 Tell us how you would conduct your investigation.

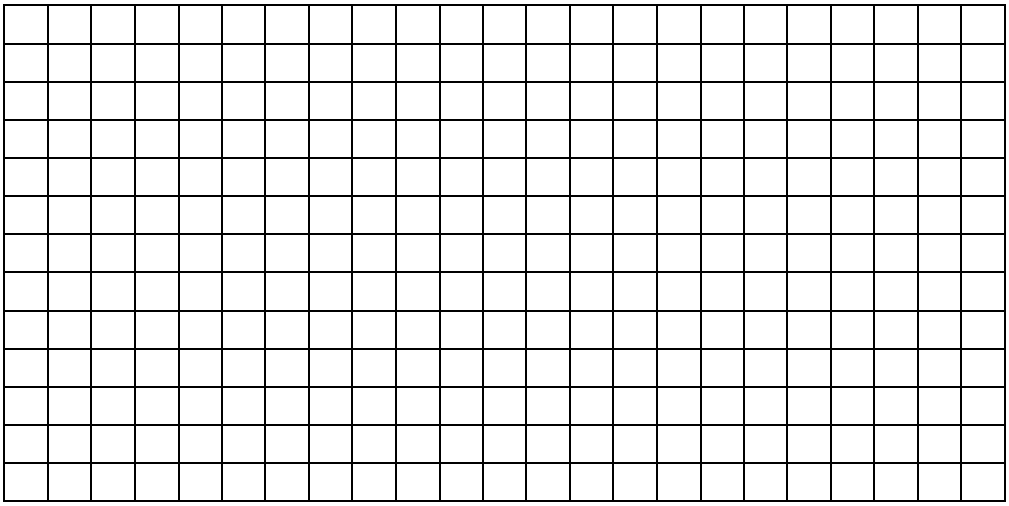
_____
_____
_____
_____
_____

3. A life sciences educator wanted to show her class the relationship between light intensity and the rate of plant growth. She carried out an investigation and got the following results.

Light intensity (candela)	250	650	1100	1300	1600	2000	2400	2800	3100	3200
Plant growth rate (cm/week)	2	5	9	11	12	15	13	10	5	0

Table 1. The relationship between light intensity and plant growth rate

3.1 You are one of the learners in the life sciences class, and your educator asks you to draw a Figure using the above results (Table 1), to show the relationship between light intensity and plant growth. Use the grid below to draw the Figure.



3.2 Which factors (variables) were being investigated by the educator?

A_____ B _____

3.3 From the results of this investigation, we may say that

A. An increase in plant growth increases light intensity.
B. An increase in light intensity decreases plant growth.
C. An increase in plant growth increases light intensity to a certain point then it decreases.
D An increase in light intensity increases plant growth to a certain point then it decreases.

4. Read the following passage carefully and answer the questions that follow, by choosing the best answer from the options given after each question. Put a cross [E] on the letter that represents your choice.

A farmer received special food from the government, for helping his cows to produce more milk. He wants to find out whether the special food could indeed increase his cows' milk production. He therefore gives the special food to 20 cows for a period of one month. He gives the same amount of normal (usual) food to 20 other cows for the same period of time. He carefully records the amount of milk produced by each of the 40 cows for a month. At the end of the month his results are as follows:

- **18 of the cows that were <u>not</u> given the special food produced just as much milk as usual, while 2 of them produced more milk.**
- **16 of the cows that were given the special food produced more milk, while 4 of them produced just as much milk as usual.**

4.1 What was the farmer trying to find out in the above investigation?

A. Whether the amount of milk produced by each of the 40 cows can be recorded
B. Whether the special food he received from the government was not poisonous
C. Whether the special food he received from the government increased milk production
D. Whether the cows feed on special food would be fatter than those feed on normal food

4.2 From the results of this investigation, we may conclude the following:

A. The special food does not help cows to produce more milk.
B. The special food helps cows to produce more milk.
C. The usual food helps cows to produce more milk.
D. Both the special food and the usual food help cows to produce more milk.

Give a reason for your choice

_____
_____

5. Read the following passage carefully and answer the questions that follow by choosing the best answer from the options given after each question. Put a cross [X] on the letter or number that represents your choice.

A learner wants to investigate the effect of acid rain on fish. She takes two jars and fills them with the same amount of fresh water. She adds fifty drops of vinegar (weak acid) to one jar, and adds nothing to the other. She selects four similar live fish, and puts two in each jar. Both pairs of fish are provided with the same amount of all their requirements (e.g. oxygen, food, etc.). After observing the fish for one week, she draws her conclusion.

5.1 Which of the following would you suggest for this experiment in order to improve it?

A. Prepare more jars with different amounts of vinegar (weak acid).
B. Add more fish to the two jars already in use.
C. Add more jars with different types of fishes.
D. Add more vinegar (weak acid) to the two jars already in use.

5.2 Select a suitable explanation for your answer to the above question from the following explanations.

1. When more fish are added to the two jars the effect of the acid will no longer be felt.
2. More jars with different types of fishes will show you a variety of effects of the acid on the fishes.
3. Preparing more jars with different amounts of vinegar will show the effect of different concentrations of acid.
4. Adding more vinegar to the two jars will produce a greater effect on the fishes and make the acid effect clearer.

THANK YOU FOR YOUR PARTICIPATION. YOUR CONTRIBUTION IS HIGHLY APPRECIATED.

THE END

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MEMORANDUM

SCHOOL._____

INSTRUMENT: TEST OF SCIENCE INQUIRY SKILLS (TOSIS)
TOTAL MARKS: 20

ITEM SPECIFICATION:

	Inquiry skills	Items	Total scores
1	Formulation of hypotheses	1.1, 2.1, 4.1	3
2	Identification of variables	1.2, 1.3, 3.2	3
3	Experimental design	2.2, 5.1, 5.2	5
4	Graphing skills	3.1	6
5	Drawing conclusions from results	3.3, 4.2	3
	Total score		20

QUESTION 1 [3] (*1 mark each*)

1.1 B
1.2 A
1.3 D

QUESTION 2 [4]

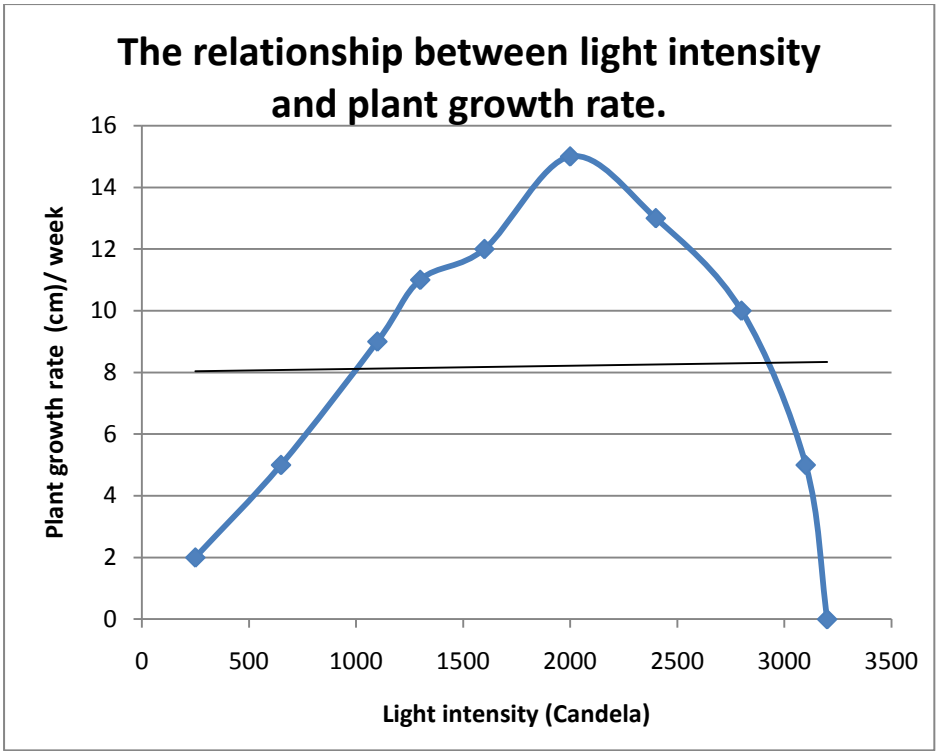
2.1 D *(1mark)*

2.2 - evidence of correct procedure (steps = *1mark)*
- indication of use of a control (*1 mark*)
- indication of some replication of the experiment *(1 mark)*

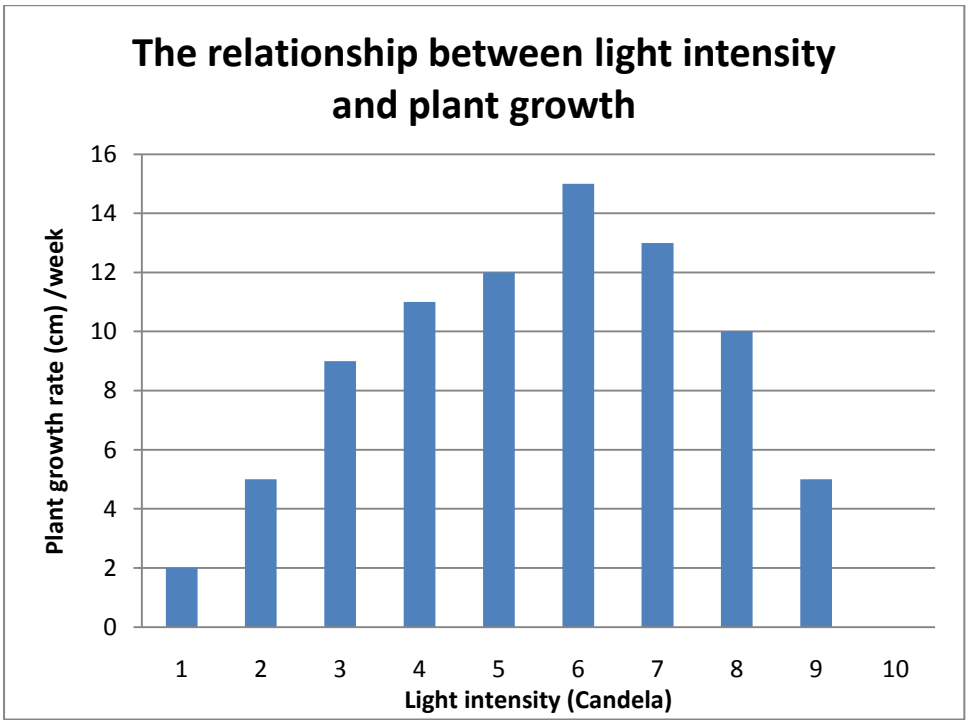
QUESTION 3 [8]

3.1 Figure *[6 marks]*

	Marks
Correct Figure	1
Appropriate scale used	2
Axis correctly placed and labelled	2
Correct title of the Figure	1
Total marks for Figure	6



OR A CORRECT HISTOGRAM WITH APPROPRIATE LABELS



3.2 Light intensity and plant growth rate *[1mark; ½ mark each]*
3.3 D *[1 mark]*

QUESTION 4 [3] THE EFFECT OF SPECIAL FOOD ON MILK PRODUCTION

4.1 C *[1 mark]*
4.2 D *[1 mark]*

Reason: More cows given the special food more produced milk than usual, and few cows given normal food produced more milk than usual (Or any similar response) *[1 mark.]*

QUESTION 5 [2]

5.1 **A** *[1mark]*For experimental design
5.2 **3** [*1 marks*] Reason for a chosen design

TOTAL MARKS = 20

Appendix IX: Decision-Making Ability Test (DMAT)

Learner code ☐

Age ☐

Grade ☐

Gender ☐

DURATION: 20 Minutes

Total Marks: 10

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. **Answer ALL the questions.**
2. **Write ALL the answers in the spaces provided for each question.**
3. **Present your answers according to the instructions for each question.**
4. **ONLY draw diagrams or flow charts when asked to do so.**
5. **Non-programmable calculators, protractors and compasses may be used.**
6. **Write neatly and legibly.**

THANK YOU FOR YOUR PARTICIPATION

QUESTION 1 **Read the following passage carefully and answer the questions that follow it.**

Tsego has been taking care of her 50-year-old father who has been suffering from a genetic disease called Huntington's disease for the past five years. When Tsego became pregnant outside marriage, she feared that her unborn child might be a carrier of Huntington's disease. She decided to go for genetic tests, which confirmed her fear. Tsego did not want her child to suffer the way her father did. She therefore wondered whether she should abort the baby or not. Tsego decided not to tell her boyfriend about the unborn baby's condition.

	FACTS ABOUT HUNTINGTON'S DISEASE
1	Huntington's disease is a dominant genetic trait, but symptoms show later in life.
2	Sick people develop involuntary tremors (shivers) of the limbs, and personality alterations, outbursts of crying, unexplained anger, memory loss and sometimes schizophrenic behaviours.
3	The seriousness of the symptoms at the various stages of the disease differs from one person to another.
4	A person may lead a normal life until the age of 50.
5	In their final years of life, patients are in a vegetative state.
6	Death usually occurs after the age of 50.
7	The average life expectancy of a healthy human being is about 75 years.
8	Abortion of an embryo at an early stage of the pregnancy is legal in South Africa.
9	Every human being has a right to life.

For question 1.1, choose the correct option by putting a cross [E] on the letter representing the correct answer.

1.1. What is the problem that needs to be considered in the story above?

A. Whether Tsego should tell the boyfriend about the condition of the baby or not.
B. Tsego became pregnant outside marriage.
C. Whether the unborn child is a carrier of Huntington's disease or not.
D. Whether Tsego should abort the baby of not.

1.2. How could Tsego handle this problem?

_____
_____

1.3. What would you advise Tsego to do? Explain.

_____
_____
_____

1.4. If your friends have views that differ from yours, would you listen to their opinions before settling on a final decision, or would you give reasons to defend your view?

Answer _____

Explain_____
_____

1.5. Should Tsego inform her boyfriend about her baby's condition and get his opinion before she makes a decision or not?

Answer _____

Explain_____
_____

QUESTION 2 Read the following case carefully and answer the questions that follow it.

You are given the responsibility of managing a school library. The roof of the school library has a lot of bats which scare some learners who want to use the library. The following table shows some facts about bats.

	FACTS ABOUT BATS
1	Bats are small flying mammals.
2	Bats can hide behind bookshelves and small spaces.
3	Bats are considered to be an endangered species (they are likely to become extinct).
4	Anyone caught killing or harming a bat may be fined up to R2000.00.
5	Bats are active at night and sleep during the day.
6	A bat can bite a human being.
7	Some bats carry rabies virus which can be transmitted to human beings through a bite.
8	Vampire bats found in Europe suck blood from warm-blooded animals.
9	Most bats eat insects including vectors such as mosquitoes, which can spread diseases.
10	Bats are good pollinators.
11	Bats help in seed dispersal.
12	Bats prefer living in natural habitats. They only live in houses when their natural habitat is destroyed.
13	Bats move very fast in an erratic (random) pattern.

For question 2.1, choose the correct option by putting a cross [☒] on the letter representing the correct answer.

2.1 What problem does the presence of the bats in the library roof present?

A. Bats are considered to be an endangered species.
B. The bats make the library look dirty.
C. Some learners are scared to use the library.
D. The R2000.00 fine for killing bats.

2.2 How would one deal with the bats?

_____
_____

2.3 Being the person responsible for managing the library, what would you do about the bats?

Answer _____

Explain_____
_____

2.4 Your assistant comes up with a suggestion which is different from yours. How would you react to this suggestion?

Answer _____

Explain_____
_____

2.5 The nature conservation board is responsible for taking care of wild life. Would you consult them before implementing your final decision?

Answer _____

Explain_____
_____

THE END

****

MEMORANDUM

CRITERIA FOR ASSESSING DECISION-MAKING ABILITY (DMAT)

Total marks: 10

CRITERIA

1	Ability to identify/state the problem in a given situation
2	Ability to consider/identify alternative options
3	Use of facts to evaluate/eliminate options and select a viable option
4	Consideration of stakeholders in making a decision.

QUESTION 1 (5 Marks)

1.1. (Criterion 1): 1 mark
A. Should Tsego tell the boyfriend about the condition of the baby or not?
B. Tsego became pregnant outside marriage.
C. Is the unborn child a carrier of Huntington's disease or not?
D. Should Tsego abort the baby of not?
1.2. (Criterion 2): 1 mark (at least 4 options; 3 or 2 options, ½ mark; 1 option, no mark)

Examples
Seek medical advice.
Abort the baby.
Keep the baby and wait to see if the problem occurs.
Keep the baby and pray for healing.
Keep the baby and be prepared to take care of it. Etc.

1.3. (criterion 3): 1 mark
Explanation - reflects ability to use facts to select a viable option among alternative options.

1.4. (Criterion 3): 1 mark
Explanation based on ability to consider alternative options and use facts to select a viable option.

For example:
Agree to consider the optional suggestion and use available facts to either accept or reject it.

1.5. (Criterion 4): 1 mark
Explanation relates to concern for stakeholders (baby, father, mother)

QUESTION 2 (5 Marks)

2.1 (Criterion 1): 1 mark

A. Bats are considered to be an endangered species.
B. The bats make the library look dirty.
C. Some learners are scared to use the library.
D. The R2000.00 fine for killing bats.

2.2 (Criterion 2): 1mark (at least 4 options; 3 or 2 options, ½ mark; 1 option, no mark)

Examples:

- Kill the bats
- Ignore them
- Allow them to escape
- Prevent them from escaping
- Seek help from wild-life specialist

2.3 (Criterion 3): 1mark

Decision and explanation based on available facts

For example:

- Fear of: being fined, making the bats extinct.
- Bats; are good pollinators, help in seed dispersal; destroy vectors.
- Bats may bite people and learners are scared of using the library.
- Bats may transmit disease to people.
- Natural habitat destroyed (therefore bats may not leave)

2.4 (criterion3): 1mark

Explanation based on ability to consider alternative options and use facts to select a viable option.

For example: Agree to consider the optional suggestion and use available facts to either accept or reject it.

2.5 (criterion 4): 1mark

Explanation relates to concern for stakeholders and consideration of available facts:

For example: Consideration for future generations, the nature conservation board, the environment, etc.

Appendix X: Problem-Solving Ability Test (PSAT)

Learner code ☐

Age ☐

Grade ☐

Gender ☐

DURATION: 30 Minutes

Total Marks 10

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. **Answer ALL the questions.**
2. **Write ALL the answers in the spaces provided for each question.**
3. **Present your answers according to the instructions of each question.**
4. **Non-programmable calculators, protractors and compasses may be used.**
5. **Write neatly and legibly.**

Problem 1: (adapted from Reeff, Zabal and Blech - DIE, 2006)

John would like the members of his family to meet for a family reunion, at his home in Pretoria. These family members live in different parts of South Africa. John wants to treat his family to a big braai during the family get-together. He is likely to get the money for the braai from his salary, which he gets on the 15th of every month. In order to involve everyone in the family, the date for the reunion should be suitable for all. Some of John's relatives go to school, and they have a month-long holiday in July. John is the only one in the family who is good at planning parties.

Imagine yourself to be John. Your appointments in July are shown in Table 1, while the appointments of your relatives in the same month are shown in Table 2.

Table 1 John's important appointments in July

Day	Date	Appointment
Thursday	1	
Friday	2	
Saturday	3	
Sunday	4	
Monday	5	
Tuesday	6	
Wednesday	7	
Thursday	8	
Friday	9	
Saturday	10	
Sunday	11	Thanks-giving at his youth club.
Monday	12	
Tuesday	13	
Wednesday	14	
Thursday	15	
Friday	16	
Saturday	17	
Sunday	18	
Monday	19	Meet with his boss.
Tuesday	20	
Wednesday	21	
Thursday	22	
Friday	23	Attend a friend's wedding.
Saturday	24	
Sunday	25	
Monday	26	
Tuesday	27	
Wednesday	28	Attend a workshop at work.
Thursday	29	Attend a workshop at work.
Friday	30	
Saturday	31	

NOTE!! John works for eight hours every day, from Monday to Friday. However, he could negotiate for leave on any day, apart from a Wednesday.

Table 2 John's family's appointments in July

Mpho	Nolwazi	Thomas	Maria	Nelisa	Ayanda
Attend a conference on July 12; See a doctor on July 26.	Any day of the week is okay, except Thursdays and on July 16.	Business appoint-ments on July 2, July 13, and July 27.	No important appointments, but has to attend youth club every Saturday.	Cannot attend the re-union on July 5, July 20 and July 24.	Will be abroad during the second week of July. Starting from the 4th of July.
Mpho and Nelisa need to use a plane to come for the reunion, while Nolwazi, Maria, Thomas and Ayanda could use their own cars or public transport.					
John's wife, Lerato, has to be at the reunion. However, she might attend a women's meeting at youth club, on the 25th of July.					

Answer the following questions concerning the family reunion.

1. What is the problem that needs to be solved in the situation described above?

   _____

   _____

2. What do you think you need to consider for you to solve the problem?

   _____

   _____

   _____

   _____

3. Which date in July is **most suitable** for John's family reunion?

   _____

4. Tell us how you arrived at this date (the steps you followed)?

_____

_____

_____

_____

_____

_____

_____

_____

_____

5. How would you make sure that this date is suitable for everyone in Johns' family?

_____

_____

_____

_____

_____

_____

Problem 2: (adapted from PISA – OECD, 2004)

A youth club is organizing a five-day children's camp. Forty-six (46) children (26 girls and 20 boys) have signed up for the camp, and 8 adults (4 men and 4 women) have volunteered to attend and organise the camp. The names of the adults who volunteered to attend the camp are; Mrs Thomson, Mrs Modiba, Ms Vyk, Ms Sanders, Mr Kiviet, Mr Neil, Mr Zulu and Mr Williams. Seven dormitories with differed number of beds are available at the camp site, as shown on the table below.

Name of dormitories	Number of beds
Red	12
Blue	8
Green	8
Purple	8
Orange	8
Yellow	6
White	6

All the people involved need to be accommodated at the camp, and the rules of the camp must be observed. The following table shows the names of the available dormitories and the number of beds in each dormitory.

Dormitory rules:

1. Males and females are **not** allowed to sleep in the same dormitory.
2. At least one adult **must** sleep in each dormitory.

Answer the following questions concerning the camp.

1. What is the problem that needs to be solved in the situation described above?

_____
_____
_____
_____
_____
_____

2. Complete the table below by allocating the 46 children and 8 adults to the dormitories.

Name of dormitory	Number of boys	Number of girls	Name(s) of adult(s)
Red			
Blue			
Green			
Purple			
Orange			
Yellow			
White			

THANK YOU FOR YOUR PARTICIPATION. YOUR CONTRIBUTION IS HIGHLY APPRECIATED.

THE END

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MEMORANDUM

CRITERIA FOR ASSESSMENT OF PROBLEM-SOLVING ABILITY
Total Marks: 10

1	Ability to define / state / clarify the problem
2	Ability to reason / explore / analyse / forecast the problem
3	Ability to plan / devise a strategy / investigate / implement the possible solution.
4	Ability to evaluate / reflect on the problem

QUESTION 1 Family reunion

1. **Problem accurately defined**: To set an appropriate date for the re-union, 1 mark.

2. **Ability to explore the problem:** date should be in July, John's appointments, relatives' appointments and commitments, John's pay date, transport needs, time for relatives to return home. **1 mark**; for three or more considerations, ½ mark; for one or two considerations, 0 mark; for no consideration.

3. **Ability to plan:** 18th of July, 1 mark; 30th of July, ½ mark; any other, 0 mark.

4. **Ability to explore the problem:** consider appointments and commitments of people involved, time when John is likely to have money, transport needs, etc. 1 mark for 3 or more steps; ½ mark for 1 or 2 steps, and 0 for no steps.

5. **Ability to evaluate the problem:** Ensure that no appointment or commitments on selected day; John is likely to have money; it meets transport needs.1 mark for 3 or more reflections, ½ mark for 1 or 2 reflections, 0 mark for no reflection.

Total marks = 5

QUESTION 2 Children's camp

1. Problem accurately defined: To set an appropriate date for the reunion, 1 mark.

2. Conditions to be satisfied for full credit = 4 marks.
   i. Total number of girls = 26.
   ii. Total number of boys = 20.
   iii. Total number of adults = 8 (4 males and 4 females).
   iv. Total number of individuals in each dormitory is within the limit for each dormitory.
   v. Individuals in each dormitory are of the same gender.
   vi. At least on adult in each dormitory.

Example of full credit response for children's camp question

Dormitory		Number of boys	Number of girls	Name(s) of adult(s)	Totals
Name	Bed capacity				
Red	12	8	0	Mr Zulu and Mr Neil	10
Blue	8	0	7	Mrs Thomson	8
Green	8	0	7	Ms Sanders	8
Purple	8	0	7	Ms Vyk	8
Orange	8	7	0	Mr Kiviet	8
Yellow	6	0	5	Mrs Modiba	6
White	6	5	0	Mr Williams	6
Totals	56	20	26	8 adults	54

Conditions for partial credits

i. Violation of 1 or 2 conditions - subtract 1 mark.
ii. Exclusion of adult (s) in the total number of individuals in each dormitory – subtract 1 mark.
iii Number of girls and boys exchanged (i.e. girls = 20 and boys = 26) - subtract 1 mark.
iv. Correct number of adults in each dormitory but names (or gender) not given – subtract 1 mark.
v. No response or other responses given - 0 mark.

NOTE:

Question 2.1 tested learners' competence in criterion 1; ability to define / state the problem. Full credit in question 2.2 demonstrates competence in three of the four criteria for problem-solving ability: Ability to reason, plan and evaluate the problem, through the allocation of the correct number of individuals to dormitories, according to complicated specified interrelated variables and relationships. That is, relationships of, male – female, child – adult, different dormitory sizes, and the fact that there were 8 adults and only seven dormitories. A partial credit showed violation of one of more of the specified conditions, thus indicating a deficiency in one or more of the stated criteria for problem-solving ability.

Appendix XI: Life Sciences Attitude Questionnaire (LSAQ)

Learner code ☐

Age ☐

Gender ☐

School code ☐

Duration: 15 minutes

INSTRUCTIONS

Please indicate how you feel about the statements shown below, by choosing (SD) for Strongly Disagree, (D) for Disagree, (U) for Undecided, (A) for Agree and (SA) for Strongly Agree. Indicate your choice by marking a cross under the option which you think best represents your feelings about the statement given, as shown in the example below.

Example

		SD	D	U	A	SA
0	My school is the best in South Africa					X

In the above example, the person put a cross under the option (SA), which indicates that he/she strongly agrees that his/her school is the best in South Africa.

Indicate on the following table, how you feel about each of the statements, by marking in the box representing the option which you think best represents your feelings, as shown in the above example.

	Statement	SD	D	U	A	SA
1	Genetics is an interesting topic to study					
2	Without the study of life sciences, it would be difficult to understand life.					
3	Performing practical activities in genetics helps me to understand genetics concepts and ideas better.					
4	Life sciences are more difficult than other science subjects.					
5	I admire people who are knowledgeable about life sciences.					
6	I like studying life sciences because of its importance in understanding life and the environment.					
7	Genetics is a difficult topic.					
8	What is taught in genetics cannot be used in everyday life.					
9	I enjoy studying genetics					
10	My future career/profession has nothing to do with genetics, so I don't study it a lot.					
11	There are too many concepts (ideas) to learn in genetics, and as a result, I have lost interest in the topic.					
12	I do not bother about what we learn in genetics because I do not understand them.					
13	Genetics will be very useful in my future career/ profession. I therefore want to study it very well.					
14	I usually feel like running out of the class during life sciences lessons.					
15	I enjoy studying life sciences.					
16	Studying life sciences is a waste of time.					
17	Ideas in genetics are not related to human needs.					
18	I do not understand how the study of genetics is related to my daily life.					
19	I do not agree with many ideas (concepts) in life sciences.					
20	I feel quite happy when it is time for genetics lessons.					
21	I hope to study genetics and life sciences further, because I want to take up a life science-related career.					
22	I really enjoy the life sciences lessons which deal with my daily life experiences.					
23	I don't like studying genetics.					
24	What is learnt in life sciences can be applied to our daily lives.					
25	I think I will have fewer job opportunities if I study genetics and life sciences.					
26	Life science is an easy subject.					
27	Discoveries in life sciences and genetics have improved human life.					
28	Life science is not my favourite subject.					
29	I sometimes avoid studying life sciences.					
30	I like setting difficult tasks for myself when studying genetics.					

THANK YOU FOR YOUR PARTICIPATION.

LIFE SCIENCES ATTITUDE QUESTIONNAIRE (LSAQ) SCORING FRAMEWORK

LEARNER CODE ☐ **GENDER** ☐

#		SD	D	U	A	SA	Rating
1	+	1	2	3	4	5	
2	+	1	2	3	4	5	
3	+	1	2	3	4	5	
4	-	5	4	3	2	1	
5	+	1	2	3	4	5	
6	-	5	4	3	2	1	
7	+	1	2	3	4	5	
8	+	1	2	3	4	5	
9	+	1	2	3	4	5	
10	-	5	4	3	2	1	
11	-	5	4	3	2	1	
12	-	5	4	3	2	1	
13	+	1	2	3	4	5	
14	-	5	4	3	2	1	
15	+	1	2	3	4	5	
16	-	5	4	3	2	1	
17	+	1	2	3	4	5	
18	-	5	4	3	2	1	
19	-	5	4	3	2	1	
20	+	1	2	3	4	5	
21	+	1	2	3	4	5	
22	-	5	4	3	2	1	
23	-	5	4	3	2	1	
24	+	1	2	3	4	5	
25	+	1	2	3	4	5	
26	+	1	2	3	4	5	
27	+	1	2	3	4	5	
28	-	5	4	3	2	1	
29	-	5	4	3	2	1	
30	-	5	4	3	2	1	
	Total score						

AN EXAMPLE OF A SCORE SHEET FOR THE LIFE SCIENCES ATTITUDE QUESTIONNAIRE (LSAQ)

LEARNER CODE 03 **GENDER** F

NO.	CAT		SD	D	U	A	SA	Rating
1	**E**	+	1	2	3	~~4~~	5	**4**
2	**A**	+	1	2	3	4	~~5~~	**5**
3	**B**	+	1	2	3	~~4~~	5	**4**
4	**D**	-	5	~~4~~	3	2	1	**4**
5	**D**	+	1	2	3	4	~~5~~	**5**
6	**A**	-	5	~~4~~	3	2	1	**4**
7	**E**	+	1	~~2~~	3	4	5	**2**
8	**A**	+	1	2	3	~~4~~	5	**4**
9	**E**	+	1	2	3	~~4~~	5	**4**
10	**C**	-	~~5~~	4	3	2	1	**5**
11	**B**	-	5	~~4~~	3	2	1	**4**
12	**B**	-	~~5~~	4	3	2	1	**5**
13	**C**	+	1	2	3	4	~~5~~	**5**
14	**B**	-	5	~~4~~	3	2	1	**4**
15	**D**	+	1	2	3	~~4~~	5	**4**
16	**D**	-	~~5~~	4	3	2	1	**5**
17	**A**	+	1	~~2~~	3	4	5	**2**
18	**A**	-	5	~~4~~	3	2	1	**4**
19	**D**	-	5	~~4~~	3	2	1	**3**
20	**E**	+	1	~~2~~	3	4	5	**2**
21	**C**	+	~~1~~	2	3	4	5	**1**
22	**A**	-	5	~~4~~	3	2	1	**4**
23	**E**	-	5	~~4~~	3	2	1	**4**
24	**A**	+	1	2	3	4	~~5~~	**5**
25	**C**	+	1	2	3	~~4~~	5	**4**
26	**D**	+	1	2	3	~~4~~	5	**4**
27	**A**	+	1	2	3	~~4~~	5	**4**
28	**D**	-	5	~~4~~	3	2	1	**4**
29	**E**	-	5	~~4~~	3	2	1	**4**
30	**E**	-	5	4	~~3~~	2	1	**3**
		Total score						**116**

Appendix XII: Science Cognitive Preference Inventory (SCPI) ☐

Learner code ☐

Age ☐

Grade ☐

Gender ☐

DURATION: 10 Minutes

INSTRUCTIONS

In this inventory we are **NOT** testing your ability. We want to find out about some of the things you like in Science. Each item in this inventory begins with some information about science. An item is followed by four statements which **all** contain **correct** information. You are asked to rank the statements according to the way you like them, by assigning numbers 4 to 1 as follows:

4. for the statement that you like most (the most interesting to you).
3. for the statement that you like second best.
2. for the statement that you like third best.
1. for the statement that you like the least (the least interesting to you).

PLEASE NOTE:

Read all four statements for each item before you start ranking them. Remember that **ALL** statements are **CORRECT**, which means that there is no correct or wrong answer. You just need to rank the statements, starting with the one you like most up to the one you like the least, by assigning them the numbers 4, 3, 2, and 1, accordingly.

EXAMPLE

It is a bright cold Saturday afternoon.		
A	Swimming conditions are excellent	4
B	A field trip to the forest will be good	1
C	There is a nice new movie starting at the cinema	3
D	A basketball match is being shown on the television	2

For the person who filled in this table, the most liked activity on a bright cold Saturday afternoon is swimming (4thranking), followed by watching a new movie at the cinema (3rd ranking), then watching a basketball match being shown on the television (2nd ranking), and a field trip to the forest is the least liked activity on a cold Saturday afternoon (1st ranking).

Select the following statements as explained in the example above.

1.	**A function of a stem of a plant is to bear leaves, flowers and later on fruits.**	
A	Fibres used in cloth are made of the stems of certain plants.	
B	The maximum height of a plant depends on the shape and the amount of wood in the stem.	
C	Some stems are soft, others are woody.	
D	How do old trees with hollow trunks remain alive?	

2.	**Bacteria are important for the living world.**	
A	Bacteria are used in the food industry in the production of foods such as cheese, yoghurt, and certain types of prickles.	
B	What would become of the carbon in dead organisms if there were no bacteria at work?	
C	Some bacteria break down dead plants and animals into their elements. By doing so, they help maintain the cycle of necessary elements.	
D	Bacteria are organisms so small that they can be seen only with the aid of a microscope.	

3.	**Living organisms may be divided into producers and consumers.**	
A	There is always a larger number of producers than consumers.	
B	What will happen to the producers if all consumers on earth disappeared?	
C	Green plants provide food and energy for most other living organisms and so they make animal and human life possible.	
D	Most producers are green plants.	

4.	**Algae are simple plants that can produce oxygen (by photosynthesis).**	
A	Algae are primary producers and fundamental to the survival of most water animals.	
B	Certain algae can be used as indicators of the conditions in fish ponds and aquaria.	
C	According to geological findings, blue algae were the first plants on earth. There could possibly be a special reason for this.	
D	Algae are classified into green, blue, brown and red algae.	

5.	**Heredity (genetics) is a topic in biology.**	
A	Genetics is used extensively (a lot) in the breeding of horses.	
B	Parents with blue eyes are likely to have children with blue eyes.	
C	Organisms (people, animals, plants) have many features in common with their parents.	
D	I wonder whether girls inherit more traits (characteristics) from their mothers than from their fathers.	

THANK YOU FOR YOUR PARTICIPATION.

ITEM SPECIFICATION FOR EACH COGNITIVE PREFERENCE MODE FOR SCPI

ITEM	OPTION	OPTION STATEMENT
APLICATION MODE (A)		
Q1	A	Fibres used in cloth are made of stems of certain plants.
Q2	A	Bacteria are used in the food industry in the production of foods such as cheese, yoghurt, and certain types of prickles.
Q3	C	Green plants provide food and energy for most other living organisms and so they make animal and human life possible.
Q4	B	Certain algae can be used as indicators of the conditions in fish ponds and aquaria.
Q5	A	Genetics is used extensively (a lot) in the breeding of horses.
PRINCIPLE MODE (P)		
Q1	B	The maximum height of a plant depends on the shape and the amount of wood in the stem.
Q2	C	Some bacteria break down dead plants and animals to their elements. By doing so, they help maintain the cycle of necessary elements.
Q3	A	There is always a larger number of producers than consumers.
Q4	A	Algae are primary producers and fundamental to the survival of most water animals.
Q5	B	Parents with blue eyes are likely to have children with blue eyes.
RECALL MODE (R)		
Q1	C	Some stems are soft, others are woody.
Q2	D	Bacteria are organisms so small that they can be seen only with the aid of a microscope.
Q3	D	Most producers are green plants.
Q4	D	Algae are classified into green, blue, brown and red algae.
Q5	C	Organisms (people, animals, plants) have many features in common with their parents.
QUESTIONING MODE (Q)		
Q1	D	How do old trees with hollow trunks remain alive?
Q2	B	What would become of the carbon in dead organisms if there were no bacteria at work?
Q3	B	What will happen to the producers if all consumers on earth disappeared?
Q4	C	According to geological findings, blue algae were the first plants on earth. There could possibly be a special reason for this.
Q5	D	I wonder whether girls inherit more traits (characteristics) from their mothers than from their fathers.

FRAMEWORK FOR DETERMINING LEARNERS' COGNITVE PREFERENCE MODES

Learner code ☐ Age ☐ Gender ☐ Cognitive preference mode ☐

	Item number	1	2	3	4	5	Total rating
A	Application	A	A	C	B	A	
	Ratings						
P	Principle	B	C	A	A	B	
	Ratings						
R	Recall	C	D	D	D	C	
	Ratings						
Q	Questioning	D	B	B	C	D	
	Ratings						
Highest total rating			Mode				

AN EXAMPLE OF LEARNERS' COGNITVE PREFERENCE SCORE SHEET

Learner code ☐ Age ☐ Gender Cognitive preference ☐

	Item number	1	2	3	4	5	Total rating
A	Application	A	A	C	B	A	
	Ratings	*4*	*4*	*4*	*2*	*1*	*15*
P	Principle	B	C	A	A	B	
	Ratings	*2*	*3*	*2*	*3*	*2*	*12*
R	Recall	C	D	D	D	C	
	Ratings	*1*	*1*	*3*	*1*	*3*	*9*
Q	Questioning	D	B	B	C	D	
	Ratings	*1*	*2*	*1*	*4*	*3*	*11*
Highest total rating		*15*	Mode			*Application*	

* Entries in italics are examples of possible ratings
* The highest total rating is considered to be the cognitive preference mode which the learner is more inclined to use.

Appendix XIII: Educator individual interview schedule

Interviewee code: ☐

Introduction:

- Thank you for agreeing to participate in this discussion on the study of genetics. My name is ....., and I work at ..... I am a researcher in the life sciences, and I am currently researching the study of genetics in schools.

- You have just finished teaching genetics, and we would like to know your views and experiences concerning the topic. It is alleged that learners find the study of genetics to be difficult. We would therefore like to find out how learners feel about the study of genetics, so that we may have a better understanding of this matter.

- In this discussion there are no wrong or right answers. Everything you say will be treated in confidence by the research team for the purpose of the research. Your views will remain anonymous, and will not be used against you in any way. You are therefore requested to feel free to say what you really think and how you really feel. You may decline from participating in the discussion at any time, and there will be no consequences for you.

- The discussion will take approximately 30 minutes, and it will be video-recorded so that I may be able to listen to our discussion at a later stage, to make sure that I capture your views correctly. The materials on the tape will not be reproduced or used anywhere else. Do you have any questions or comments before we start?

Questions:

1. How would you describe learners' performance in the genetics topic that you just taught?
2. In your opinion, what do you think could be the reason for this performance?
3. Tell me about learners' attitude towards the study of genetics and life science as a subject?
4. What do you think the cause of this attitude could be?
5. Tell me what you think about the relevance of genetics to learners' daily life experiences? Why do you think so?
6. According to your experience, how would you describe learners' perception of genetics in relation to its relevance to their daily lives?
7. In your opinion, what is the most effective way of teaching genetics?
8. Is there anything else that you would like to add?

Thank you very much for your participation and patience. Your contribution is highly appreciated.

Educator individual interview themes

Educator interviews focused on

- Opinions concerning learner performance in genetics and life sciences.
- Educators' opinion on the approach(es) used to teach genetics.
- Opinions on the relevance of the study of genetics to learners.
- Opinions concerning learners' attitude towards the study of genetics and life sciences.

Appendix XIV: Learner focus group interview schedule

Focus group Number: ☐

Introduction:

- I am very grateful to you all for sparing the time to take part in discussions on the study of genetics. My name is ....., and I work at ..... I am a researcher in the life sciences, and I am currently researching the study of genetics in schools.

- You have just completed the study of genetics, and we would like to know how you feel about it. The reason for our discussion is to try to understand what learners think about the study of genetics, so that we may find effective ways of teaching the topic.

- Your views and feelings will be treated in confidence amongst the research team, for the purpose of the research. Anything you say will remain anonymous, and will not be used against you in any way, including assessing or judging you. There are no wrong or right answers. Everyone's contribution is important, welcomed and encouraged. You are therefore requested to feel free to say what you really think and how you really feel. You are free to decline from participating at any time if you so wish, and there will be no consequences for you.

- The discussion will take approximately 30 minutes, and it will be video-recorded so that we may be able to listen to it at a later stage, to make sure that we capture your views correctly. The materials on the tape will not be reproduced or used anywhere else. Do you have any questions or comments, before we start?

Questions:

1. Let's talk about your experience of the study of genetics, did you like it or not? Tell me why you feel that way.
2. In your opinion, do you think the study of genetics relates to your daily life? Why do you say so?
3. How do you feel about the way genetics was taught? Would you have liked it to be taught in a different way? Tell me more.
4. Tell me what you think about the study of genetics? Do you consider the study of genetics to be easy or difficult to learn? Tell me why you think so.
5. After studying genetics, you wrote a test to assess your understanding of the topic. Tell me what you think of your performance in the test?
6. Imagine that the minister of education has asked you to make suggestions on how you would like genetics to be taught. What would you say to him/her?
7. Is there anything else regarding the study of genetics that you would like to share with us?

Thank you very much for your participation and patience. Your contribution is highly appreciated.

THE END

Learner focus group interview themes

Learner focus group interviews were based on the following themes:

- Opinions on performance in genetics.
- Opinions on the way genetics was taught.
- Opinions on the relevance of the study of genetics to learners' lives.
- Opinions on interest in the study of genetics.

Appendix XV: Pilot study results.

Learner code	Gender	SCPI Modes		TOSIS Scores (%)		DMAT Scores (%)		PSAT Scores (%)		GCKT scores (%)		LSAQ Scores (/150	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
p1	F	A	A	10	15	35.0	35.0	10.0	15.0	7	9	98	100
p2	F	P	A/P	10	15	40.0	30.0	30.0	25.0	14	16	106	112
p3	F	R	R	15	20	40.0	45.0	20.0	25.0	11	13	113	112
p4	M	A	A	25	30	30.0	35.0	20.0	30.0	22	23	101	105
p5	F	A	A	30	35	35.0	30.0	25.0	25.0			104	102
p6	M	R	R	25	30	65.0	70.0	15.0	20.0	6	9	91	98
p7	F	P/R	P	15	15	10.0	20.0	20.0	25.0	3	3	90	90
p8	M	R	R	50	45	10.0	15.0	25.0	30.0	11	10	107	109
p9	F	Q	Q	20	25	50.0	40.0	15.0	10.0	10	11	97	100
p10	M	Q	P	25	30	10.0	20.0	40.0	35.0	20	22	97	99
p11	M	P	P	20	35	20.0	25.0	30.0	30.0	15	18	116	103
p12	F	Q	Q	10		30.0		10.0		21		111	
p13	F	Q	Q	35	40	30.0	40.0	15.0	15.0	14	17	115	114
p14	M	R	R	25	30	50.0	55.0	20.0	20.0	15	16	109	107
p15	F	Q	Q	20	25	50.0	45.0	15.0	15.0	14	16	89	93
p16	M	P	P	25	30	65.0	70.0	15.0	20.0	11	15	84	85
p17	M	R	R	25	20	10.0	10.0	20.0	20.0	9	15	107	107
p18	M	P	P	35	30	10.0	20.0	20.0	20.0	22	27	106	104
p19	M	R	R	10	10	50.0	60.0	30.0	15.0	15	16	91	97
p20	F	R	R	15	20	10.0		15.0		17	16	106	111
p21	M	P	P	20	30	10.0	15.0	45.0	45.0	13	19	91	95
p22	F	P	P	25	25	50.0	55.0	35.0	40.0	18	14	106	103
p23	F	P	Q	35	40	30.0	30.0	20.0	25.0	11	13	118	116
p24	M	Q	Q	30	25	60.0	55.0	25.0	35.0	11	14	73	84
p25	F	P	P	25	25	20.0	30.0	10.0	15.0	15	18	113	
p26	F	R/Q	Q	15	20	20.0	15.0	20.0	30.0	11	10	82	90
p27	M	A	A	15	15	50.0	50.0	10.0	10.0	16	18	85	87
p28	F	R	R	15	10	30.0	30.0	25.0	20.0	20	22	103	100
p29	M	R	R	40	30	10.0	15.0	15.0	15.0	16	17	114	113
p30	F	Q	Q	10	20	50.0	50.0	10.0	10.0	18	18	115	113
p31	M	P	P	35	30	10.0	10.0	25.0	35.0	11	13	102	107
p32	M	Q	Q	20	20	10.0	15.0	15.0	20.0	18	20	96	98
p33	F	P/R	P	5		10.0	10.0	25.0	20.0	14	14	117	114
p34	F	Q	Q	25	25	30.0	25.0	15.0	15.0	16	17	97	101
p35	F	R	R	20	25	30.0	25.0	20.0	20.0	13	20	100	98
p36	F	R	R	25	25	60.0	65.0	10.0	10.0	15	17	101	105
*Reliability Coefficient		P =0.001		0.83		0.95		0.82		0.88		0.93	
Duration		10 minutes		30 minutes		20 minutes		30 minutes		1 hour		15 minutes	

*A chi-square test of was used to determine the association between the cognitive preferences in the 1st and 2nd administrations of the SCPI instrument.
*Reliability coefficients for the other instruments (GCKY, TOSIS, DMAT, PSAT, and LSAQ) were determined using Pearson correlation coefficient.

Appendix XVI: Comparison of pre-test control and experimental mean scores ($\bar{x}$)for LSAQ items according to attitude categories

Item Code	Item statement	N	Control MEAN ($\bar{x}$) ± SD	N	Experiment MEAN ($\bar{x}$) ± SD	p-value
CATEGORY (ATT 1): APPLICATION OF LIFE SCIENCES / GENETICS TO EVERYDAY LIFE						
RA2	Without the study of life sciences, it would be difficult to understand life.	99	4.000 ± 1.088	86	3.906 ±1.013	0.550
RA6	I like studying life sciences because of its importance in understanding the environment.	99	4.081 ± 0.899	86	4.000 ±1.147	0.593
RA8	What is taught in genetics cannot be used in everyday life.	99	4.252 ± 0.982	86	4.209 ±0.855	0.752
RA17	Ideas in genetics are not related to human needs.	99	4.353 ± 0.799	86	4.400 ±0.710	0.679
RA24	What is learnt in life sciences can be applied to our daily lives.	99	4.545 ± 0.558	86	4.465 ±0.730	0.399
RA27	Discoveries in life sciences and genetics have improved human life.	99	4.181 ± 0.719	86	4.127 ±0.823	0.635
CATEGORY (ATT 2): LEARNERS' PERCEPTION OF LIFE SCIENCES/GENETICS LESSONS / CLASSES						
RA3	Performing practical activities in genetics helps me to understand genetics concepts and ideas better.	99	4.494 ± 0.690	86	4.523 ±0.681	0.780
RA11	There are too many concepts (ideas) to learn in genetics, as a result, I have lost interest in the topic.	99	3.515 ± 1.521	86	3.541 ±1.350	0.903
RA12	I do not bother about what we learn in genetics because I do not understand them.	99	4.222 ± 1.064	86	4.209 ±0.971	0.932
RA14	I usually feel like running out of the class during life sciences lessons.	99	4.494 ± 0.660	86	4.313 ±1.008	0.146
RA18	I do not understand genetics lessons.	99	4.141 ± 0.903	86	4.209 ±0.841	0.599
RA20	I feel quite happy when it is time for genetics lessons.	99	3.858 ± 0.958	86	3.930 ±0.992	0.618
RA22	I really enjoy the life sciences lessons which deal with my daily life experiences.	99	4.464 ± 0.836	86	4.372 ±0.920	0.475
CATEGORY (ATT 3): LEARNERS' PERCEPTION OF LIFE SCIENCES CAREER PROSPECTS						
RA10	My future career/profession has nothing to do with genetics, so I don't study it a lot.	99	4.050 ± 1.163	86	4.151 ±1.090	0.546
RA13	Genetics will be very useful in my future career/ profession. I therefore want to study it very well.	99	4.121 ± 1.189	86	4.081 ±1.019	0.809
RA21	I hope to study genetics and life sciences further, because I want to take up a career in medicine.	99	4.080 ± 0.944	86	3.988 ±0.999	0.519
RA25	I will have fewer job opportunities if I study genetics and life sciences.	99	4.222 ± 0.909	86	4.162 ±0.794	0.639
CATEGORY (ATT 4): LEARNERS' OPINION OF GENETICS AS A TOPIC						
RA1	Genetics is an interesting topic to study.	99	4.464 ± 0.812	86	4.337 ±0.876	0.306
RA7	Genetics is a difficult topic.	99	3.474 ± 1.043	86	3.477 ±1.092	0.989
RA9	I enjoy studying genetics.	99	3.656 ± 1.070	86	3.895 ±1.052	0.129
RA23	I don't like studying genetics.	99	4.121 ± 1.003	86	4.360 ±0.796	0.077
RA30	I like setting difficult tasks for myself when studying genetics.	99	3.222 ± 1.129	86	3.477 ±0.979	0.106
CATEGORY (ATT 5): LEARNERS' OPINION OF LIFE SCIENCES AS A SUBJECT						
RA4	Life science is more difficult than other science subjects.	99	4.101 ± 1.025	86	4.105 ±0.908	0.979
RA5	I admire people who are knowledgeable about life sciences.	99	4.060 ± 0.901	86	3.756 ±1.073	0.037*
RA15	I enjoy studying life sciences.	99	4.323 ± 0.902	86	4.314 ±0.885	0.944
RA16	Studying life sciences is a waste of time.	99	4.666 ± 0.622	86	4.663 ±0.696	0.968
RA19	I do not agree with many ideas (concepts) in life sciences.	99	3.868 ± 1.036	86	3.930 ±0.918	0.672
RA26	Life science is an easy subject.	99	3.353 ± 1.145	86	3.186 ±1.153	0.324
RA28	Life science is not my favourite subject.	99	4.151 ± 1.081	86	4.221 ±1.045	0.659
RA29	I sometimes avoid studying life sciences.	99	4.354 ± 0.799	86	4.400 ±0.710	0.610

* Indicates a significant treatment effect at α = 5% significance level.

Appendix XVII: **Summary of post-test statistics on the interactive influence of gender on specific categories of science inquiry skills**

Inquiry skills Component	Treatment	Gender	N	mean ($\bar{x}$)	SD	F-value	p-value
OT1	E	F	44	3.977	2.040	0.00	0.9989
		M	41	3.902	2.095		
	C	F	50	5.880	2.624		
		M	30	5.833	1.895		
OT2	E	F	45	5.222	4.258	2.59	0.0552
		M	41	4.927	3.349		
	C	F	50	4.100	3.872		
		M	30	4.167	3.495		
OT3	E	F	45	7.778	6.619	0.90	0.3440
		M	41	7.195	8.066		
	C	F	50	7.100	5.632		
		M	30	8.667	8.503		
OT4	E	F	45	7.778	7.654	1.22	0.2703
		M	41	4.878	7.201		
	C	F	50	6.200	4.468		
		M	30	5.667	3.651		
OT5	E	F	45	3.778	4.542	0.03	0.8595
		M	41	3.049	4.312		
	C	F	50	5.700	4.739		
		M	29	4.828	4.721		

KEY:
OT1 = ability to formulate hypotheses
OT2 = ability to identify variables
OT3 = ability to design experiments
OT4 = competence in Graphing skills
OT5 = ability to draw conclusions from results
E = experimental group
C = control group
F = female learners
M = male learners

Appendix XVIII: Summary of post-test ANCOVA statistics for the interactive influence of cognitive preferences and treatment for the different components of science inquiry skills

Inquiry skills variables	Cognitive preference	CONTROL			EXPERIMENTAL			F Value	p-value
		N	Mean	SD	N	Mean	SD		
OT1	A	14	3.57142857	2.34403615	15	6.33333333	2.96808420	0.41	0.7470
	P	25	4.60000000	1.38443731	26	6.53846154	2.35339362		
	Q	15	4.66666667	3.99404318	18	5.00000000	1.71498585		
	R	22	3.40909091	2.38365647	10	5.50000000	2.83823106		
OT2	A	14	4.28571429	4.32218911	15	4.66666667	3.99404318	0.00	0.9998
	P	25	3.80000000	3.89444048	26	4.23076923	3.65849906		
	Q	15	4.66666667	3.99404318	18	4.44444444	3.79197639		
	R	23	3.26086957	4.15842399	10	4.00000000	3.94405319		
OT3	A	14	7.14285714	7.26273039	15	7.00000000	6.21059003	0.31	0.8215
	P	25	8.40000000	6.87992248	26	7.50000000	6.20483682		
	Q	15	6.66666667	6.98638131	18	7.77777778	7.32084498		
	R	23	6.95652174	7.64840008	10	9.00000000	9.94428926		
OT4	A	14	12.1428571	10.1364320	15	6.0000000	2.8030596	1.84	0.1420
	P	25	5.8000000	6.0690472	26	6.3461538	4.8078462		
	Q	15	6.0000000	7.6063883	18	6.6666667	4.8507125		
	R	23	4.7826087	6.6534784	10	4.5000000	2.8382311		
OT5	A	14	1.78571429	3.72473172	15	4.33333333	5.62731434	0.13	0.9450
	P	25	5.00000000	4.78713554	26	6.53846154	4.18789464		
	Q	15	3.00000000	4.55129495	17	5.58823529	4.28746463		
	R	23	3.04347826	3.91359241	10	4.00000000	5.16397779		

KEY:
OT1: Ability to formulate hypotheses
OT2: Ability to identify variables
OT3: Ability to design experiments
OT4: Graphing skills
OT5: Ability to draw conclusions from results
A: Application mode
P: Principle mode
Q: Questioning mode
R: Recall mode
SD: Standard deviation

Appendix XIX: Summary of post-test ANCOVA statistics for the interactive influence of gender, cognitive preferences and treatment on learning outcomes

Dependant variable	Cognitive preference	Gender	CONTROL			EXPERIMENTAL			F Value	p-value
			N	Mean	SD	N	Mean	SD		
GCKT	A	F	7	16.1038961	5.7905187	11	27.1074380	10.0067595	1.98	0.1199
		M	8	15.4545455	7.8954203	5	30.1818182	7.8834485		
	P	F	13	16.7832168	9.3051674	20	27.5454545	9.8580618		
		M	13	13.8461538	5.4816730	7	34.5454545	7.7138922		
	Q	F	9	19.7474747	11.3707049	10	29.2727273	13.3457243		
		M	6	15.7575758	8.0220083	9	28.6868687	13.8998120		
	R	F	16	13.9659091	6.6054385	8	22.7272727	8.7467316		
		M	12	14.3560606	5.7996163	3	11.5151515	4.5756572		
TOSIS	A	F	7	32.8571429	17.5254916	10	30.5000000	10.3949774	0.74	0.5278
		M	7	25.0000000	19.5789002	5	24.0000000	7.4161985		
	P	F	12	33.7500000	9.5643752	20	30.5000000	11.3439063		
		M	13	21.9230769	11.4634313	6	33.3333333	8.7559504		
	Q	F	9	25.5555556	12.6106216	8	30.6250000	8.2104028		
		M	6	21.6666667	11.6904519	10	28.0000000	11.5950181		
	R	F	13	21.5384615	16.8800444	7	22.8571429	7.5592895		
		M	10	21.0000000	9.6609178	3	36.6666667	22.5462488		
DMAT	A	F	7	61.4285714	27.3426233	11	70.0000000	20.4939015	0.96	0.4122
		M	8	50.0000000	20.0000000	5	80.0000000	23.4520788		
	P	F	13	50.0000000	26.1406452	20	67.5000000	20.4874801		
		M	13	53.0769231	22.5035610	7	72.8571429	14.9602648		
	Q	F	8	63.7500000	25.0356888	10	73.0000000	16.3639169		
		M	6	46.6666667	31.4112506	10	74.0000000	17.1269768		
	R	F	13	53.0769231	29.8285700	8	73.7500000	15.0594062		
		M	9	50.0000000	21.2132034	3	53.3333333	11.5470054		
PSAT	A	F	7	25.7142857	24.3975018	11	38.1818182	23.1595258	0.49	0.6905
		M	8	42.5000000	14.8804762	5	52.0000000	26.8328157		
	P	F	13	41.9230769	21.5579125	20	53.5000000	25.8079955		
		M	13	34.2307692	16.6890875	7	48.5714286	24.1029538		
	Q	F	9	31.6666667	20.0000000	10	55.0000000	26.7706307		
		M	6	33.3333333	25.0333111	10	41.0000000	26.0128174		
	R	F	14	24.6428571	15.1231211	8	53.7500000	28.7538817		
		M	9	37.2222222	22.2361068	3	46.6666667	40.4145188		
LSAQ	A	F	6	115.333333	20.5491281	11	130.636364	9.7187728	0.38	0.7659
		M	7	119.714286	23.9563094	5	129.200000	12.8918579		
	P	F	10	127.800000	19.6061215	17	129.470588	7.8749416		
		M	12	119.750000	12.6284311	7	126.142857	10.6681547		
	Q	F	9	113.777778	18.8399693	7	127.428571	5.9681695		
		M	6	110.166667	12.8750405	9	128.666667	7.6157731		
	R	F	14	109.000000	20.9321247	6	122.166667	11.8053660		
		M	10	121.500000	13.8343373	3	131.333333	20.8166600		

KEY

GCKT:	Genetics Content Knowledge test	A:	Application mode	F:	Female
TOSIS:	Test Of Science Inquiry Skills	P:	Principle mode	M:	Male
DMAT:	Decision-Making Ability	Q:	Questioning mode		
PSAT:	Problem-Solving Ability	R:	Recall mode		
LSAQ:	Life sciences Attitude Questionnaire	SD:	Standard deviation		

Appendix XX: Chi-square test for the correlation of pre- and post-intervention cognitive preferences for the experimental group.

Pre-test	Post-test				Total
	A	P	Q	R	
A	7 (3.15)	2 (4.33)	3 (3.74)	1 (1.77)	13
P	3 (5.09)	14 (7.00)	1 (6.05)	3 (2.86)	21
Q	2 (4.61)	3 (6.33)	12 (5.47)	2 (2.59)	19
R	4 (3.15)	3 (4.33)	3 (3.74)	3 (1.77)	13
Total	16	22	19	9	66
Exact p-value = 0.0003					

Appendix XXI: Interview protocols

(A) FOCUS GROUP INTERVIEWS

Key: ES = Experimental group learner
CS = Control group learner

Experimental groups

ET (School code)

Table 1 Learners' perception of performance in the study of genetics

ES3	When I wrote the first test (pre-test), it was difficult, but after studying genetics, I felt more excited, and it became easy. I think I passed the second test (post-test).
ES26	I think genetics is an easy topic and I passed the test (post-test).
ES15	I think genetics was interesting and fun, except the cloning part, but I think I passed the test (post-test).
ES20	If all educators taught us the way sir did, we would never fail any subject. I enjoyed looking back at my original ideas.
ES23	The topic of genetics is too long. It should be shortened, because you can easily forget what you learnt earlier.
ES15	The way our educator taught us made it easy. We talked about things that happen to us, so it was easy to understand. I especially enjoyed the part on diseases and the inheritance of features from our parents.

Table 2 Tell us how you experienced the teaching of genetics and how you like to be taught genetics

ES28	The stories made the study of genetics easy because we managed to understand what was happening, and we were able to explain the situations.
ES3	We would like to be taught other subjects the way we were taught genetics.
ES20	I would suggest that they include the genetics topic in Grades 10, 11 and 12, because it is very interesting.
ES26	They should train educators on how to teach genetics so that the results of the learners could be better.
ES26	Mr "X" should teach other educators how to teach life sciences.
ES15	Some learners like studying on their own. Then it becomes difficult, but when we study in groups like we did in this programme, it becomes easy to understand because we help and learn from one another.
ES20	"Some educators are too lazy to explain to learners what is happening. They just give you notes from the textbook or tell you to go home and read from 'page 159', and tell you to explain what you read to the class. It was difficult to understand. But in the method used in this project, it was not like that. We understood what we were learning.

Table 3 Learners' perception of the relevance of the study of genetics

ES3	Genetics consists of many terms and principles, but it is easy and important because it teaches us about how we are related to our parents and ancestors, and it shows us how we pass our genes to the generations still to come.
ES23	It was easy because it was all about everything that was happening in our lives.

Table 4 Learners' opinions on their interest in the study of genetics

ES15	I found genetics to be interesting. The more you study, the more interesting and easy it became.
ES9	I am interested in genetics because it helps me understand many things in life, such as how we look alike with our siblings, and how we pass genes to other generations
ES26	The practical activities in genetics were very interesting, because we were able to see the things that we study in theory.
ES9	The cloning topic was very interesting.
ES16	It was fascinating and interesting at the same time. I liked and understood the part which talked about how genes determine my appearance.
ES23	Genetics was more interesting than other topics.

EU (School code)

Table 5 Learners' perception of performance in the study of genetics

ES39	The study of genetics was easy because we were able to link it to what happens in our homes
ES57	The practical lessons made the study of genetics easy.
ES45	If the things we learn are put to us as stories, it becomes easier to understand, rather than just give us past questions which we do not know how they relate to our lives
ES53	After learning genetics the way we did, I am sure we will pass the examination with distinctions. If we don't, it will be because of the other topics in life sciences, not genetics.
ES53	I feel that we will perform better in genetics than in other topics.

Table 6 Tell us how you experienced the teaching of genetics and how you like to be taught genetics

ES55	I liked the stories before each lesson because they made me understand what we were learning.
ES44	The genetics programme that we followed should be compulsory so that everyone can benefit from it, because those who missed the programme are disadvantaged.
ES48	The method we used to learn genetics should be used in other topics in life sciences and other science subjects, not just in genetics, so that we may understand what we learn.
ES57	The way we normally learn other topics is through theory, where we are asked to just read from a text book. At the end of the day nothing makes sense.

Table 7 Learners' perception of the relevance of the study of genetics

ES39	After studying genetics, I understand most of the things that happen in our societies, like why we have albinos.
ES44	The study of genetics was easy because we were able to link it to what happens in our homes.
ES54	We can catch criminals using genetics, and even men who refuse the responsibility of a child.
ES51	The study of genetics is good for us because we know how it affects us, and we understand some of the issues we hear on TV.

Table 8 Learners' opinions on their interest in the study of genetics

ES42	Genetics was very interesting and fun. I used to look forward to the lessons.
ES55	I liked the fact that we were not just learning genetics in theory, but we were also doing practical activities.
ES42	The fact that we were dealing with things that happen in our lives made the study of genetics very interesting.
ES53	The study of genetics was interesting because we did it practically, which made it easier to understand.
ES57	When we learnt genetics, our educator allowed us to give our views, but with the other topics, we are usually not given an opportunity to say what we think.
ES34	Because of the way we were taught genetics, I am now interested in genetics, because it helped me to understand many things in life, such as how we happen to look alike with our brothers and sisters.

EV (School code)

Table 9 Learners' perception of performance in the study of genetics

ES82	I think the practical activities helped me to understand the concepts better.
ES64	The stories made me realize the myths which I had, and by studying genetics I managed to know the truth.
ES68	The discussions made me to understand genetics concepts very well.
ES70	It was easy to understand the terms and ideas because we worked in groups and we learnt from one another. If you are wrong, your friends explained the reasons to you.
ES77	It was more exciting and fun, and it is easy to remember what we learnt.
ES68	It was fun to learn genetics by using our own experiences. It just makes genetics so easy. I am sure I have passed the test.

Table 10 Tell us how you experienced the teaching of genetics and how you like to be taught genetics

ES69	The way sir taught us was different. In other classes, learners do not understand exactly what the educators teach us, because it is mostly theory.
ES60	In other classes, there is no interaction between us and the educators, but here we are allowed to say what we think, even to argue with others or disagree with the educator.
ES68	Other educators come and stand in front and talk and talk and talk, telling you things that you see in the textbooks. They just tell us what to do and we follow. It is not fun.
ES79	The method used to teach genetics in this project was more practical, but other educators teach us theory only, which we don't understand.
ES77	Everything about the topic was perfect. The practical activities and the stories made the topic fun.
ES64	The nice thing about the lessons was that we were talking about things that happen in our homes. I now understand why my brother looks so different from all of us.

Table 11 Learners' perception of the relevance of the study of genetics

ES65	The study of genetics helps us improve our daily lives and deal with the challenges that we have in our lives.
ES77	Genetics, it is good to study it. It teaches us a lot of things about ourselves.
ES65	Genetics is easy because it is about things that happen to us.
ES69	We learnt about things that happen in our lives. It was interesting to know what happens in your own life, and it was easy to remember what we learnt.

Table 12 Learners' opinions on their interest in the study of genetics

ES60	Genetics is interesting because it explains things that we see in our lives. For example, we used to think that people with disabilities were bewitched, but now we understand that it could have been the result of genetic mutations.
ES68	It was interesting to learn that most genetic diseases are incurable, so it means that when you marry you have to be careful and know whether your husband is carrying the genes that cause the disease or not.
ES65	I enjoyed the practical activities because they were about things that we see and that we hear from people.
ES79	It was very interesting. At first I thought it was difficult. I really enjoyed the part on cloning of animals.
ES82	It was interesting because I learnt about things which I did not understand before, especially about my own body.

CONTROL GROUPS - CW (School code)

Table 13 Learners' perception of performance in the study of genetics

CS108	Genetics was interesting, but when it comes to tests and examinations, we get scared or panic and fail, or we don't pass the way we expect to pass.
CS120	Genetics is difficult because it is just rules and terms which are difficult to understand
CS97	I found the study of genetics to be difficult, because some of the terms, I cannot put them in my mind, especially the definitions, they are very confusing.
CS112	Genetics is challenging because some of us do not understand what it is based on.
CS123	Genetics is difficult because we do not understand it, and the educators don't allow us to ask too many questions.
CS100	I think we find genetics to be difficult, because we don't study it and we don't apply what we learn outside the classroom.

Table 14 Tell us how you experienced the teaching of genetics and how you like to be taught genetics

CS126	If we are given more time to study genetics, we might perform well, because when we get to the examination, we don't remember what we studied.
CE105	I think that if our educators can teach us extra strategies for studying genetics. Then we may understand it better and perform well.
CS102	I would like to see more practical activities in our genetics lessons.
CS120	We should be going to places like museums so that we can see the issues we learn about.
CS116	They should make DVDs which we can watch at home, so that we may understand
CS123	The problem is that we do not do any practical activities in genetics. We would like to do practical activities so that we may understand genetics.
CS100	Educators must be active because the lessons are sometimes boring.
CS100	I think genetics should be taught early in Grade 11 so that when we reach Grade 12, we will understand it better.

CS97	Some of our educators just read from the textbook or give us questions from past examination papers, so we don't understand what is going on.
CS116	Educators must be able to communicate with learners, not just get angry when we ask questions.
CS115	Our educators should organize trips to places where we can see what we learn in class.
CS123	The way our educators teach us, makes us fail, because we find it boring. They just read from textbooks, then they give us many exercises, so we just 'cram' *(memorize)* the work because we don't understand.

Table 15 Learners' perception of the relevance of the study of genetics

CS116	I think genetics is important to our lives, but we do not know how to apply it to our lives.
CS112	The study of genetics and life sciences helps us to know how to take care of ourselves.
CS97	Genetics makes us aware of how gene mutations can cause disabilities and disorders in our bodies.

Table 16 Learners' opinions on their interest in the study of genetics

CS106	Genetics is interesting because we learn about ourselves, how we are made, and how certain characteristics come about.
CS102	Some of us do not understand what genetics is all about.

CX (School code)

Table 17 Learners' perception of performance in the study of genetics

CS131	For me it was difficult because the terms used were difficult for me to understand
CS145	The study of genetics was fine, it wasn't easy or difficult.
CS142	Genetics needs a lot of interpretations and a clear understanding.
CS130	It is not that easy because it requires a lot of time for us to understand.
CS156	I would say it was difficult because the way we learn genetics is different from the way the questions are asked in the examination.
CS132	What makes it difficult is that we can't really see the things which we learn about.

Table 18 Tell us how you experienced the teaching of genetics and how you like to be taught genetics

CS130	I think genetics could be easier if we can be shown videos which show how the genetics processes take place.
CS141	We should be using microscopes to see what really happens in the cells.
CS130	The use of games might also help us understand genetics better.
CS139	If we can put the genetics terms in a song, it will help us remember them because music is liked by many young people.
CS156	Genetics should be taught very early, say in Grade 7 and we should continue learning it until Grade 12, so that we may understand it better.
CS131	I think the use of practical activities can help us understand genetics better.
CS146	They should organize field trips to places where genetics is practised so that we may see for ourselves what goes on.
CS131	We want to be involved in the lessons. Our educators talk and talk and talk, and we get bored, and at times feel sleepy.
CS145	We should be allowed to participate in lessons so that we can know where we are wrong or right.

Table 19 Learners' perception of the relevance of the study of genetics

CS145	Genetics is important, because it helps us to know whether a child belongs to you or to somebody else.
CS132	In genetics we study what happens in our bodies, so I think it is relevant.
CS130	It can be relevant if we talk about things which we can see, not just things we imagine in our minds.

Table 20 Learners' opinions on their interest in the study of genetics

CS132	Genetics was interesting because it deals with things that affect our lives.
CS145	I found it interesting because of the way the educator framed the question about genetics.
CS106	Genetics is interesting because we learn about ourselves, how we are made, and how certain characteristics come about.

CY (School code)

Table 21 Learners' perception of performance in the study of genetics

CS168	Learners forget what they have learnt because biological terms are too difficult to understand.
CS181	Learners forget what they have learnt because genetics has many things to learn about and some of the terms are similar, so it is not easy to remember them.
CS167	Some learners learn by cramming (memorization) without interest, and without thinking about what they have crammed. They just want to pass the examination. They don't think about why these things happen.
CS188	Learners do not read to understand the things that they have been taught. Life sciences need people who read a lot.
CS173	I think the problem is our perspectives. We tend to think that the topic is difficult just because the terms used are not familiar to us.
CS188	Learners fail genetics because they do not understand the biological terms. You have to know the terms for you to understand the topic.

Table 22 Tell us how you experienced the teaching of genetics and how you like to be taught genetics

CS173	People fail genetics because of the methods used by educators to teach genetics.
CS181	Some educators start teaching genetics without us knowing where it comes from, where it is situated and how it affects us.
CS181	Educators should be trained on how to teach properly.
CS167	They (educators) should use practical activities and examples which should include things like diseases that are caused by genetics. It will be easier to understand, because we would be able to apply what they teach us in our lives.
CS188	The educators are the ones that make the study of genetics difficult, because most of them pretend to know genetics, but just follow what is written in textbooks, and they do not help us understand what is going on.
CS173	I think after learning something, we should answer a lot of questions individually so that we can know our weaknesses.
CS167	Theory should be balanced with practical activities.
CS188	More time should be provided for the study of genetics.
CS188	Learners should be more involved in science lessons.
CS168	Educators should always relate what we learn to real-life issues, and give more examples of how the things we learn can be applied in life.

Table 23 Learners' perception of the relevance of the study of genetics

CS173	Yes, genetics is important, because it teaches us about what is happening in our bodies.
CS188	If educators can show us how the genetics processes really happen, it would be very important, because we would know how the study of genetics helps us.
CS167	I think most life sciences topics are important to us, because we learn about the different processes that take place in our bodies.
CS173	Some of the things are relevant, but others are not.

Table 24 Learners' opinions on their interest in the study of genetics

CS167	If we can go to places where they deal with genetics, to observe what happens, then the study of genetics would be easy and interesting.
CS173	Some learners are stereotyped. They think that genetics is difficult, so they lose hope and put little effort in trying to understand it, and they end up failing.

EDUCATOR INTERVIEWS: Key – ET = Experimental group educator
CT = Control group educator

ET (School code)

Table 25 Educators' opinions on learners' performance in the study of genetics

ET1	The performance of learners in life sciences, especially genetics is usually not good. I think it is because learners prefer hands-on activities for them to understand the content, but educators normally don't do practical activities, because of large classes and lack of resources, so they just teach theory.
ET1	In the examination it is assumed that learners can apply what they were taught, and they end up asking practical questions so the learners end up failing the subject.
ET1	During our normal classes, it is like Greek to the learners. They don't understand most of the things, and they end up getting confused.
ET1	The learners who were involved in this programme are advantaged because they really understood the concepts.
ET1	What made them understand genetics was the teaching method of starting the lesson with real-life issues (*narratives*), and then relating the concepts to those issues. Then the lessons made sense to them.
ET1	Learners who were taught using the new method really understood the lessons, because they were able to relate everything they did in class to what happens in real life.

Table 26 Educators' opinions on their ability to identify and address learners' preconceptions

ET1	It was very interesting. Learners have so many ideas about genetics related issues
ET1	What surprised me is that some learners could explain genetics related issues even before they were given the content.
ET1	When you listen to their arguments, you could easily pick out the wrong explanations and the correct ones, and during the content introduction, most learners corrected themselves, and I also emphasized the ideas which they misunderstood.
ET1	This teaching method is a good way of knowing what to stress and where to explain more in the lessons.
ET1	The method also helped me to know what learners misunderstand in genetics.

Table 27 Educators' opinions on the most appropriate and effective way of teaching genetics

ET1	The use of real-life examples made the study of genetics more interesting and easier to understand.
ET1	If you link real-life issues with the syllabus, they become more meaningful and clearer to the learners.
ET1	Most educators do not usually link their lessons to issues happening outside the classroom. They rush to finish the syllabus by just presenting theory. In the end the learners do not understand anything, that's why we have high failure rates.
ET1	Most of the teaching in our normal classes is educator-centred, whereas the genetics programme we had was learner-centred.
ET1	I think the learners really appreciated the teaching method used in the programme. They even ask me why I don't teach them using the same method, but it is not possible for me to use it in a large class where there are no resources.
ET1	I think the best way of teaching genetics is to link the lessons to learners' real-life experiences just as we did in the programme.
ET1	When learners are able to relate their lessons to real-life experiences, they won't memorize, because they answer the questions with understanding.
ET1	The only problem with this method is that we cannot apply it now because we do not have the enough resources for practical activities.
ET1	What I liked is that, in the content introduction phase when you 'touch' on issues where learners had alternative conceptions, they would ask for clarification.

Table 28 Educators' opinions on the relevance of studying genetics, to learners' lives

ET1	Yes, I think genetics has an impact on learners' lives, because they learn about nature.
ET1	And I know that the learners who were involved in this programme saw how genetics impacts on our lives. What they learnt will be useful throughout their lives.

Table 29 Educators' opinions on learners' interest and participation in the study of genetics

ET1	The learners were very interested in the lessons. They all wanted to say something and convince the others about their views.
ET1	They enjoyed the practical activities a lot. They could easily see the processes that are explained in theory. Frankly, I did not know that there were such interesting practical activities in genetics.
ET1	They were always looking forward to the stories at the beginning of the lesson and the practical activities which showed them what they had learnt in theory.
ET1	At times, you would hear them discussing and arguing about the issues outside the classroom. It was nice to see them so excited about their lessons.
ET1	You know, even other learners who were not part of the programme wanted to join us, but it was too late for them.

ET (School code)

Table 30 Educators' opinions on learners' performance in the study of genetics

ET2	The learners who were exposed to the new teaching approach performed much better when compared with my previous learners' performance.
ET2	One outstanding aspect of the new approach is that the learners become very active during lessons, and therefore the learners understood the lessons better.

Table 31 Educators' opinions on their ability to identify and address learners' preconceptions

ET2	With the new method of teaching, it was easy to know what the learners know and what they did not know, because they were given the opportunity to express their views before being taught.
ET2	Learners have many ideas and opinions on scientific issues. When asked where they got the answers from, they said they just heard from other people.
ET2	In the content introduction phase when you 'touch' on some of their misconceptions, they would ask for clarification.
ET2	Some learners had correct information about issues related to genetics even before the topic was taught. Such learners were usually excited when the genetics concepts confirmed their ideas.

Table 32 Educators' opinions on the most appropriate and effective way of teaching genetics

ET2	Genetics topics usually pose a lot of teaching challenges for educators and comprehension difficulties for learners, but the teaching method used in this programme made it easier for learners to understand.
ET2	In traditional teaching approaches, learners feel intimidated by the educators, and they do not have the opportunity to relate their thoughts and daily life experiences with what is learnt in class, so that they may become inquisitive and want to learn more.
ET2	The lessons highlighted situations and problems, and then provided explanations and possible solutions as they unfolded in the various stages.
ET2	What I really like about this approach is that it encourages team work, develops problem-solving skills, communication skills, tolerance and understanding of diverse cultures.
ET2	Learners were attentive and receptive to the information at all stages, which really helps in making them understand the topic even better when they review their previous answers to the questions.
ET2	The context interrogation stage allows for interaction and discussion, and it paves the way for the information stage where the content relating to that scenario is presented by the educator.
ET2	Other learning areas can easily and effectively be integrated into the context and content.
ET2	It also forces educators to relate what they teach to what happens in real-life.
ET2	The teaching approach used in this programme turned out to be an exciting and interesting experience to teach learners. This is because situations and problems, which relate to their everyday lives are used.
ET2	To me, as an educator, context based method, when followed correctly, will always achieve the expected objectives. All life sciences learning outcomes can be addressed, when you use the new teaching method.
ET2	Each lesson, compared to the traditional way of teaching, requires more time to complete.
ET2	The educator needs to be well prepared and collect sufficient information for content, because there will be lots of questions to answer.
ET2	I would say it requires time, careful selection of content load, selection of relevant comprehensible context for the lesson and the following of the stages systematically, with a lot of discussion and writing for the learners.
ET2	My area of concern is that in most traditionally black schools, there is overcrowding in classes, and since this method required grouping of learners, total effectiveness of this approach may somehow to an extent be compromised.
ET2	I had the opportunity to use this technique to teach genetic topics and personally feel it can work very well in teaching other Life Sciences topics, especially other controversial topics, like evolution, organ donation.
ET2	I have all the confidence that Life Sciences performance will improve, and educators will find it very exciting.

Table 33 Educators' opinions on the relevance of studying genetics, to learners' lives

ET2	I believe everyone knows that most of the topics in life sciences are relevant to everyone including learners. We study life.
ET2	Genetics is the basis of life itself. Without genes, there is no life, so the study of genetics is relevant to the learners.
ET2	It makes the learning of life sciences relevant to their everyday life.

Table 34 Educators' opinions on learners' interest and participation in the study of genetics

ET2	Learners were very enthusiastic and motivated to learn more.
ET2	The new teaching approach turned out to be an exciting and interesting experience to teach learners. This is because situations and problems which relate to their everyday lives are used.
ET2	The learners are kept interested throughout the lesson,
ET2	It helps learners construct their own knowledge and always keeps them actively involved.
ET2	Learners enjoyed the practical activities a lot. They could easily see the processes that are explained in theory. Frankly, I did not know that there were such interesting practical activities in genetics.

ET3 (School code)

Table 35 Educators' opinions on learners' performance in the study of genetics

ET3	When learners see and relate to what the educator is saying, they understand things better and faster, hearing and listening skills are lacking in our learners.
ET3	The use of contexts in the lessons helped learners to quickly remember the things learnt, because they can relate the concepts to situations which they are familiar with.
ET3	Once you tell them what happens in real life, and then teach them the relevant genetics concepts, it becomes easier for them to understand.
ET3	The hands-on activities also helped the learners to understand the genetics concepts well.

Table 36 Educators' opinions on their ability to identify and address learners' preconceptions

ET3	Certainly, and most of the misconceptions were related to their cultural beliefs, such as witchcraft. If you start a lesson by saying to the learners, tell me something, then they feel free to tell you what they know, and then you can pick up misconceptions and correct them.
ET3	Yes, learners have very interesting and strange ideas about life. They came up with uninformed answers, solutions, myths, and beliefs, before the information stage.
ET3	What is good is that during the information phase, you have the opportunity to explain, and emphasize those issues where you noted the misconceptions.

Table 37 Educators' opinions on the most appropriate and effective way of teaching genetics

ET3	The approach (used in the study) involves a two way interaction between the educator and the learners. It is a two-way form of communication. In our schools, it is always a one-way communication where the educator says, and the learners have to accept what the educator has said. Learners do not ask questions because what the educator says is considered right.
ET3	The approach (used in the study) is practical in nature, which is lacking in traditional approaches.
ET3	Probing learners to give you what they understand about the topic makes them think broadly. It therefore increases their thinking capacity, and makes them want to know more.
ET3	The involvement of learners in the lessons made them feel appreciated, because they felt that the little they knew from home was integrated in the lessons.
ET3	In traditional teaching approaches, learners feel intimidated by the educators, and they do not have the opportunity to relate their thoughts and daily life experiences with what is learnt in class, so that they may become inquisitive and want to learn more.
ET3	I would like to mention that the context-based approach is also helpful to the educator. It is a fact that most educators do not understand what they teach. This approach forces educators to understand what they teach because they know that the learners are likely to ask questions which they might not know how to answer.
ET3	I did not know that one could conduct interesting experiments in genetics. It was very difficult to come up with genetics experiments which learners could be interested in, and which made sense. This method of teaching is really good.
ET3	It was time consuming. Adequate time is required to get information from learners and to correct their misconceptions.
ET3	However the disadvantage of time may not be an issue if the approach is used well, because if the learners understand very well, then you can move faster. But if they don't understand then you may have to repeat the topic many times for them to eventually understand.

Table 38 Educators' opinions on the relevance of studying genetics, to learners' lives

ET3	The advantage of the way genetics was taught in this programme is that learners know that what is taught in class is actually happening in their own communities.

Table 39 Educators' opinions on learners' interest and participation in the study of genetics

ET3	For the first time, I did not have to force my learners to talk. In fact I had to control them at times. Everyone wanted to say something.
ET3	The learners were very excited during lessons, especially during phase 4 (*where learners were required to link the content learnt to the context previously explored*). At times it was difficult to control them, because they came up with so many questions and suggestions.
ET3	The teaching method used kept learners interested throughout, and it stimulated in the learners the need to want to know more or research more on the topic.
ET3	The use of real-life situations in the lessons helped learners to quickly remember the things learnt, because they can relate the concepts to situations which they are familiar with.
ET3	The exploration of contexts stage allows for interaction and discussion, and it paves the way for the information (concept) stage where the content relating to that scenario, is presented by the educator.

Control groups

CT4 (School code)

Table 40 Educators' opinions on learners' performance in the study of genetics

CT4	I would say they fail because they believe that genetics is very complex, so they just shut down.
CT4	I can't pick up exactly where the problem lies, it's probably the way we teach genetics, or the type of resources that we use, because we normally use the chalk board, posters, textbooks, old models, and they don't seem to be effective in enhancing learners' achievement in genetics.
CT4	Probably learners are just lazy to study.

Table 41 Educators' opinions on their ability to identify and address learners' preconceptions

CT4	Because they are usually quiet, it is difficult to know what they think, or what they know or don't know.
CT4	Our learners are scared or shy to express themselves and reveal what they think. I think they are also scared that their friends will laugh at them if they speak broken English, because as you know, English is not their mother tongue, and they are not good at it.

Table 42 Educators' opinions on the most appropriate and effective way of teaching genetics

CT4	I normally teach genetics lessons by giving an introduction, involving some background to the lesson, and then I speak more about the lesson and give them content from the textbook, and then some exercises to do.
CT4	I think the way we teach genetics is limited to the sense of hearing. Our learners are not good at exploring issues on their own. They are very much reliant on the educator.
CT4	Some learners are afraid of giving the wrong answer, because they are not confident about what they say.
CT4	I think practical activities may help learners to understand genetics and life sciences as a subject.
CT4	I really think that genetics is a very interesting subject. If we find out what the problem is, then our learners might perform better in genetics.

Table 43 Educators' opinions on the relevance of studying genetics, to learners' lives

CT4	I believe that genetics is relevant and important to learners' lives, because it teaches them about the inheritance of diseases and certain abnormalities.

Table 44 Educators' opinions on learners' interest and participation in the study of genetics

CT4	Learners like genetics because it is an interesting topic.
CT4	Learners are usually curious during lessons. They are inquisitive, and have some interest in the lessons, but then they do not seem to understand the concepts.
CT4	I think there should be more courses to train educators on how to teach genetics.

CT5 (School code)

Table 45 Educators' opinions on learners' performance in the study of genetics

CT5	I think most learners have problems with the application of genetics.
CT5	At times what makes learners get lost during the study of genetics is the way educators present the lessons as abstract concepts.
CT5	Generally, I would say learners understand certain part of genetics, but not others.
CT5	I also think that the main problem with the study of genetics is that the application parts were just introduced in the syllabus recently, so most educators struggle to understand those parts, especially those who have decided not to study further.

Table 46 Educators' opinions on their ability to identify and address learners' preconceptions

CT5	We know the parts that confuse learners and some of their beliefs, so if you are a good educator, you can easily address them.
CT5	At times when you ask them a question, they just stare at you without saying anything, so it is difficult to know what they are thinking.

Table 47 Educators' opinions on the most appropriate and effective way of teaching genetics

CT5	The best way to teach genetics is by linking it to what happens in learners' lives.
CT5	I think experts should teach educators on how to teach genetics properly, so that learners can understand what they are taught.

Table 48 Educators' opinions on the relevance of studying genetics, to learners' lives

CT5	Of course genetics is very relevant to learners, but they need to understand it for them to appreciate it.
CT5	The teaching of genetics should be linked to real life, then it becomes relevant to learners.

Table 49 Educators' opinions on learners' interest and participation in the study of genetics

CT5	I would say learners generally like the study of genetics, but not all the different concepts of genetics.
CT5	What I know is that learners always enjoy topics which they find easy to understand. If they think that something is difficult, they won't like it.
CT5	Even some educators are not comfortable with some parts of genetics, so how can they arouse learners' interest and improve performance in those parts?

CT6 (School code)

Table 50 Educators' opinions on learners' performance in the study of genetics

CT6	Probably they are not just good at mastering the genetics concepts. I really don't know why they can't grasp the concepts.
CT6	What I notice with my classes is that they seem to understand the lessons when we start the study of genetics, but as we get deeper into the processes and applications of genetics, they get lost, and become bored.
CT6	Learners' performance in genetics is very poor. The average mark is around 30%.

Table 51 Educators' opinions on their ability to identify and address learners' preconceptions

CT6	At times, learners say things which are not scientifically true, then we correct them.
CT6	When learners don't understand, they usually keep quiet. Therefore you can't really know what they are thinking. Even if you ask them a question about that part, they won't answer.

Table 52 Educators' opinions on the most appropriate and effective way of teaching genetics

CT6	I believe that the way I normally teach is the best way of teaching genetics, because I always strive to do the best in whatever I do.
CT6	I usually start with a mind capture, like something that happened somewhere, to capture their attention. Then I teach them the concepts, and give them an assessment to see if they have followed the lesson.
CT6	I think practical activities can help to clarify the theory, but the problem is that, there are very few practical activities in genetics, and the materials are expensive, so we end up teaching the theory.

Table 53 Educators' opinions on the relevance of studying genetics, to learners' lives

CT6	Yes I think that learners realize the importance of genetics to their lives, although there are some topics which they think are not important to their lives, such as the study of plants.

Table 54 Educators' opinions on learners' interest and participation in the study of genetics

CT6	Most learners don't like the application parts because they find them difficult. They are only interested in the parts which they understand.
CT6	At times they appear to have some kind of fear of the topic, because they think it is difficult.
CT6	Some educators are very strict, and some of them use corporal punishment to make the learners respect them, so the learners are afraid of saying something that may annoy the educator, and end up being afraid to say anything in class.

Appendix XXII: Permission from the University of Pretoria to conduct research

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1908 - 2008

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

FACULTY OF EDUCATION
DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION
Groenkloof Campus
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Republic of South Africa
Tel: +27 12 420 –5572
Fax: +27 12 420-5621

TO THE DISTRICT DIRECTOR
DEPARTMENT OF EDUCATION

HEAD OF DEPARTMENT
Science, Mathematics and Technology Education

DATE; 31st AUGUST 2009.

Dear sir/Madam

RE: PERMISSION TO CONDUCT A RESEARCH PROJECT – Ms. M.M.. Kazeni

The above mentioned is a PhD student at the University of Pretoria, and we would like to request your permission to allow her to conduct a research relating to the "Effectiveness of context-based teaching approaches in Life sciences, in South African schools." She would like to conduct the research in four schools randomly selected from the Tshwane South Educational district. As part of her research, she would like to compare the effectiveness of context-based and traditional teaching approaches in enhancing learners' performance in Life sciences. In order to conduct the research, she will need to develop context-based teaching materials and expose them to learners as an enrichment program (outside the normal learning time). Performance of learners using the context-based teaching approach will be compared with that of learners using the traditional (usual) teaching approach for the same Life sciences topic(s).

The successful completion of this research is likely to provide insights into the effectiveness of context-based teaching approaches (which form part of the OBE curriculum) on learners performance and attitudes towards the study of life sciences, and the relevant contexts. It will also enable Ms Kazeni to complete her PhD study.

The researcher will need to satisfy and adhere to the highest ethical standards as required for research projects of this nature, and prescribed by the University of Pretoria, which include as far as possible anonymity and confidentiality of participants and participating schools. The outcomes of the study will be made available to the participating schools upon request.

Your cooperation will be highly appreciated.

Regards

Prof. G.O.M. Onwu
Supervisor

Ms. M.M. Kazeni
Researcher.

Appendix XXIII: Permission from the provincial Department of Education to conduct research

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries: Nomvula Ubisi (011)3550488

Date:	05 November 2009
Name of Researcher:	Kazeni Monde Monica
Address of Researcher:	54 Chantepark
	Poligoon Street
	Meyerspark
Telephone Number:	0124205734/0835186515
Fax Number:	0124205621
Research Topic:	The Relative Effectiveness of Context-based and Traditional Teaching Approaches on Learners' Performance in Life Sciences, in some South African Schools
Number and type of schools:	10 Secondary Schools
District/s/HO	Tshwane South

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*

Office of the Chief Director: Information and Knowledge Management
Room 501, 111 Commissioner Street, Johannesburg, 2000 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0809 Fax: (011) 355-0734

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Pp Nomvula Ubisi
Martha Mashego
ACTING DIRECTOR: KNOWLEDGE MANAGEMENT & RESEARCH

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	10/11/2009

Appendix XXIV: Permission from principals of participating schools

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1908 - 2008

UNIVERSITEIT VAN PRETORIA
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DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION
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Pretoria 0002
Republic of South Africa
Tel: +27 12 420 –5734
Fax: +27 12 420-5621
http:// www.up.ac.za

Natural sciences building
Office no. 208.

Date: 4th December, 2009

Dear Sir/Madam,

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR SCHOOL, ON THE USE OF CONTEXT-BASED TEACHING APPROACH IN LIFE SCIENCES

My name is Ms. Kazeni, Monde, M.M., a registered PhD student at the University of Pretoria. I wish to refer to the above mentioned subject and inform you that in accordance with permission granted by the Gauteng Department of Education to conduct research in some schools in Tshwane South Educational district, your school has been selected to participate in the research.

The performance of learners in sciences including the Life Sciences in South African schools has been declining since 2003, despite concerted efforts by the government and other stake holders to remedy the situation. Life Sciences are becoming increasingly relevant in dealing with health, environmental and economic issues in our societies. It therefore becomes necessary to investigate different ways (including teaching approaches) of addressing the problem of poor performance of learners in the Life Sciences. In this research, a teaching approach which relates the teaching of Life Sciences to learners' daily experiences (context-based teaching) will be investigated. This approach attempts to emphasize the relevance of Life Sciences education to learners' lives. The research involves exposing grade 11 Life Sciences learners to either a context-based teaching approach, for the experimental group, or to a traditional/normal teaching approach, for the control group, on the same topic(s). Thereafter, the performance of both groups of learners on the topic(s) taught will be assessed and compared.

The research will be undertaken during the second term in 2010, and it will take the form of an enrichment programme, envisaged to take place after school hours. Therefore, the normal teaching and learning of participants will not be affected. Educators involved with the experimental groups will be trained on how to use the context-based teaching approach. After the intervention and assessment, a sample of participating learners will be selected to take part in a focus group discussion, in order to establish their perceptions on the use of the context-based teaching approach. Participating educators will also be interviewed to get their views on the effectiveness of the context-based teaching approach. The likely benefits of the study will include:

1. Gaining some insights into the range of contexts which learners feel could facilitate the understanding and enjoyment of some topics in the Life Sciences.
2. An indication of the effectiveness and efficiency of context-based teaching (which is part of the OBE system) in improving learner performance in, and attitude towards the study of Life Sciences.
3. Professional development of participating educators in context-based teaching.

I undertake to maintain confidentiality, and that neither the school nor the participants will be identified in the study report. The school and participants will be free to withdraw from the study anytime without any repercussions. In line with the departmental (DoE) regulations, a letter of informed consent will be given to participating learners and educators to indicate their willingness to participate in the research, as it is important that their participation is voluntary.

Your school may participate in the study as one of the experimental or control schools. I therefore request your consent to participate in this research project on a voluntary basis. Your assistance in this matter will be highly appreciated by myself and the University of Pretoria. Kindly indicate your willingness to grant the requested permission by signing in the space provided below.

Yours faithfully

Kazeni Monde, M.M.
(Researcher)
---------- Date 04/12/09
(Signature of the researcher)

Prof G.O.M. ONWU
(Supervisor)
---------- Date 4/12/09
(Signature of the supervisor)

Prof M. Braun
(Head of Department)
---------- Date 4/12/09
(Signature of the head of Department)

HEAD OF DEPARTMENT
Science, Mathematics and
Technology Education

CONFIRMATION OF PERMISSION TO CONDUCT RESEARCH AT THE SCHOOL

I Prof/ Dr/Mr/Mrs/Ms, ---------- the principal of ----------
----------(name of school)
hereby grant Ms. Kazeni M, M.M., permission to conduct research at this school on the above stated topic.

---------- Date----------

(Signature of the Principal)

Appendix XXV: Letter of consent to participating educators

LETTER OF INFORMED CONSENT FOR EDUCATORS.

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1908 - 2008

UNIVERSITEIT VAN PRETORIA
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DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION
Groenkloof Campus
Pretoria 0002
Republic of South Africa
Tel: +27 12 420 –5734
Fax: +27 12 420-5621

Date: 4th February 2010.

Dear Educator:

RE: REQUEST TO PARTICIPATE IN A RESEARCH PROJECT.

You may be aware that the performance of South African high school learners in sciences, including life science, has been declining for almost a decade now. You are invited to participate in a research project which attempts to address the problem of poor performance in life science. In this project, we will try to see how different teaching approaches may help in improving the performance of learners in genetics, a topic which learners are said to find difficult to understand.

If you are interested in participating in the research project, your role will involve helping in teaching learners using either a context-based teaching approach, or the traditional (normal) way of teaching. Educators involved in teaching the context-based materials, will be thoroughly trained on how to use them. Teaching sessions will take place after school, as enrichment lessons. Therefore, your involvement in the project is not likely to affect your normal teaching schedule.

The researcher will make occasional visits to your class during lessons, for the purpose of identifying any challenges related to the implementation of the approaches, **NOT** for assessing you. We hope to videotape some of the lessons in order to capture the learning atmosphere. Also, some of the participating educators will be interviewed at the end of the project, to determine their perceptions of the use of the particular teaching approach in enhancing learner performance.

We would appreciate if you could participate in this project, as we believe that it will contribute to furthering our knowledge on how to significantly improve learner performance in life science. You have the right to decline, or withdraw from participation any time, without any repercussions. Your participation or non participation in the project, and the outcomes of the study will have **NO** consequences whatsoever, on your profession as an educator, or on your personal reputation. All data collected during the project will be treated confidentially by using pseudonyms.

If you are willing to participate in this research, please kindly write your name and sign on the line below.

Name of educator…….. **Signature**……

Date:……..

Yours sincerely

Name of researcher: Kazeni Monde. M. M. **Signature**……

Date: 18/02/10

Supervisor: Prof G.O.M. Onwu:…….. **Signature**……

Date: 24/02/10

Appendix XXVI: Letter of informed consent to parents

LETTER OF INFORMED CONSENT FOR A MINOR CHILD.

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1908 - 2008

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DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION
Groenkloof Campus
Pretoria 0002
Republic of South Africa
Tel: +27 12 420 –5734
Fax: +27 12 420-5621

Date: 4th February 2010

Dear Parent(s)/Guardian(s):

RE: REQUEST FOR PERMISSION TO INVOLVE YOUR CHILD IN A RESEARCH PROJECT.

I am writing to ask your permission for your child to participate in a research project aimed at addressing the problem of poor performance in life science. In this project, we will teach your child genetics, a topic that is considered difficult to learn. Different teaching approaches will be used in order to determine which one is more effective in improving learner performance in genetics.

In this project, lessons will be presented after school, as part of the learner after school enrichment project, offered by the University of Pretoria. Your child's school is already part of this after school enrichment project. This means that your child's participation in the research project is not likely to change her/his daily schedule. Your child will have the opportunity of studying genetics again when it will be taught during normal school lessons.

The research project is expected to be an enjoyable and beneficial experience for your child, and will **NOT** require any additional costs or responsibilities from you. We are hoping that your child will benefit from the project by improving her/his knowledge in genetics. We do not anticipate any risks or harm to your child during the research project.

Any information obtained from assessments done during the project will be used for this research only. Individual children's results will not be shared with the school staff. Participation in this study will therefore not affect the assessment of your child by the teachers, and will not be in the school records.

Participation in this research is voluntary. Both you and your child have the right to decline, and you can withdraw your child from participating in the project any time, without any repercussions. Only learners who volunteer to participate, and whose parents/guardians willingly permit them to do so, will be considered for the project. We will appreciate if you could allow your child to take part in this study.

Should you have any concerns or questions regarding your child's participation in this project, please contact Ms Kazeni, M.M. at telephone number: 012 420 5734 or e-mail address: monde.kazeni@up.ac.za. If you have any questions about the rights of your child as a participant, you may contact the University of Pretoria, Faculty of Education, Ethics Committee, at 012 420 3751.

If you are willing to allow your child to participate in the study, please kindly write your name and sign on the lines below, and return the letter to the school as soon as possible.

Name of parent/guardian.....**Signature**.....

Date:.....

Yours sincerely

Name of researcher: Kazeni Monde. M. M. **Signature**.....

Date: 18/02/10

Supervisor: Prof G.O.M. Onwu **Signature**.....

Date: 24/2/10

Appendix XXVII: Permission from the University of Pretoria Ethics Committee to conduct research

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Education

Faculty of Education

Ethics Committee

21 April 2010

Dear Ms Kazeni

REFERENCE: SM10/03/02

Your application was carefully considered and discussed during a Faculty of Education Ethics Committee meeting on 20 April 2010 and the final decision of the Ethics Committee is:

Your application is approved.

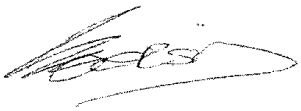
This letter serves as notification that you may continue with your fieldwork. Should any significant changes to the study occur after approval was given, it is your responsibility to notify the Ethics Committee immediately.

Please note that this is **not a clearance certificate**. Upon completion of your research you need to submit the following documentation to the Ethics Committee:

1) Investigator(s) Declaration that you adhered to conditions stipulated in this letter (D08/01).
2) Investigator(s) Declaration for the storage of research data and/or documents (Form D08/02).
3) Supervisor's Declaration for the storage of research data and/or documents (Form D08/03).

On receipt of the above-mentioned documents you will be issued a clearance certificate. Please quote the reference number SM10/03/02 in any communication with the Ethics Committee.

Best wishes,



Prof Liesel Ebersohn
Chair: Ethics Committee
Faculty of Education