



GENETICS AND INHERITANCE



Checklist

Make sure you:

- Know how to distinguish between:
 - Genetics
 - Inheritance
 - Variation
- Know how to outline the experiments conducted by Mendel
- Can explain the difference between each of the following:
 - Chromatin and chromosomes
 - Genes and alleles
 - Phenotype and genotype
 - Dominant and recessive alleles
 - State Mendel's Law of Dominance
 - Homozygous (pure-breeding) and heterozygous (hybrid)
 - Monohybrid cross and dihybrid cross



Exam Questions

Question 1

(Adapted from March 2013, Paper 1, Question 1)

- 1.1 Explain:
- 1.1.1 The principle of dominance
 - 1.1.2 Mendel's law of segregation
- 1.2 Distinguish between:
- 1.2.1 Complete, incomplete and co-dominance
 - 1.2.2 Heterozygous and homozygous
 - 1.2.3 Phenotype and genotype
 - 1.2.4 Harmful (lethal) mutations, harmless mutations and useful (fixed) mutations
 - 1.2.5 Genetic engineering and biotechnology
- 1.3.1 Suggest why Mendel's choice of pea plants for his investigation on inheritance was a good choice.
- 1.3.2 Why did Mendel repeat his investigation several times?
- 1.4 Classify the following examples as being examples of complete, incomplete or co-dominance:
- a. Yellow Corn x Red Corn – Red Corn
 - b. Brown dog x White dog – Brown spotted dog
 - c. Yellow Fish x Red Fish – Orange Fish
 - d. Blue flower x yellow flower – 1 blue : 2 green : 1 yellow flower



Question 2

(Adapted from Feb 2009, Paper 1, Question 3)

2.1 Read the passage below and answer the questions that follow.

GENETICALLY MODIFIED PIG BRED WITH 'GOOD FAT'

Scientists in the United States of America have produced genetically modified pigs with fat containing omega-3 fatty acids. These fatty acids, which are usually found in salmon, mackerel and fresh tuna, are thought to be responsible for a number of benefits, from combating heart disease to improving intelligence.

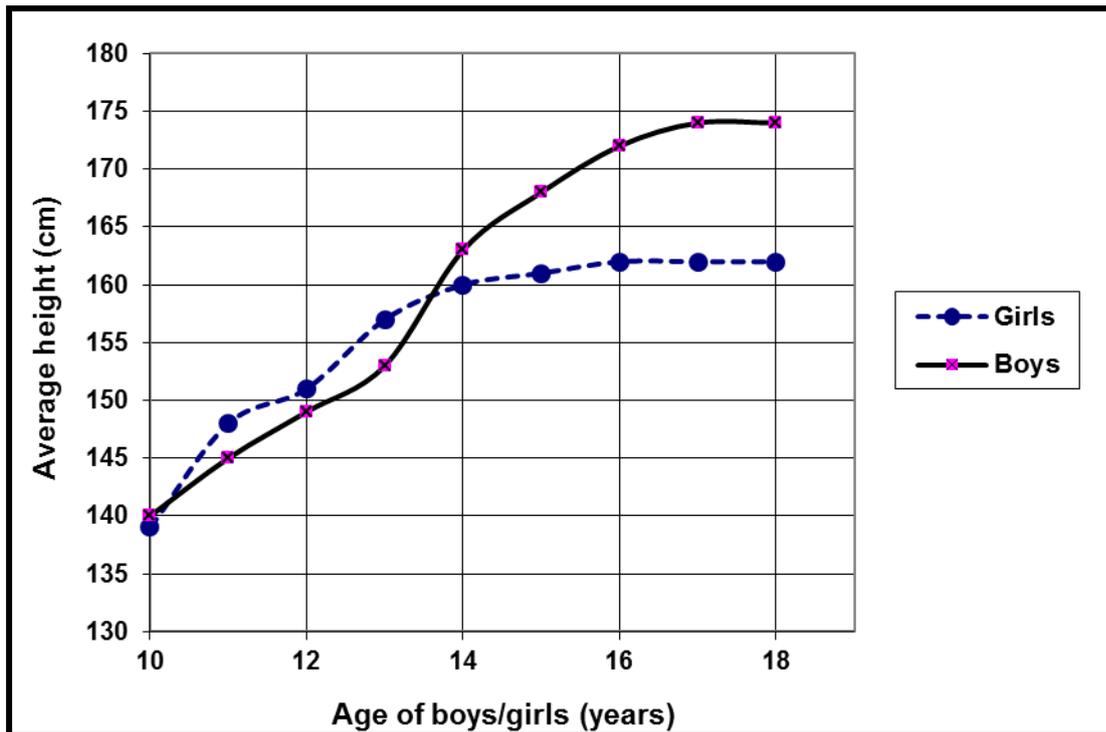
Researchers from the University of Pittsburgh – School of Medicine created piglets capable of converting less useful omega-6 fatty acids into omega-3 fatty acids. They implanted 1 800 embryos into 14 female pigs. Ten live offspring, which were able to make high levels of omega-3 fatty acids, were born.

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

- 2.1.1 Name TWO health benefits of omega-3 fatty acids. (2)
- 2.1.2 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)
- 2.1.3 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)
- 2.1.4 Give TWO reasons why:
- a) Some people may support the use of genetically modified pigs to produce omega-3 fatty acids (2)
 - b) Some people may be against the use of genetically modified pigs to produce omega-3 fatty acids (2)
- 2.2. Cow's milk is different from human milk. Cow's milk should not be given to young human babies. Scientists in China have genetically engineered cows to produce human milk. Milk from these cows can be fed to young human babies.
- a.) What is genetic engineering?
 - b.) Suggest a reason why some people are worried about using milk from genetically engineered cows, to feed human babies.
- 2.3 A group of Grade 12 learners were asked to test the following hypothesis with regard to phenotypes:
- At each age group boys are taller than girls.**
- 2.3.1 Name any THREE steps in the planning process that must be considered in this investigation. (3)



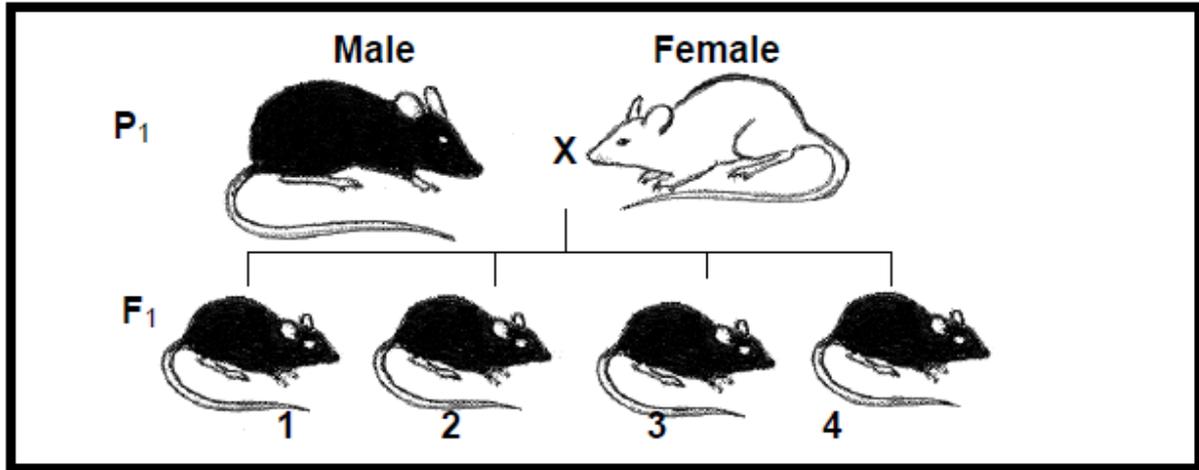
2.3.2 The results of the learners' investigation are shown in the graph below.



- a.) At what age is the average height of the boys and the girls the same? (1)
- b.) Provide a caption for the graph. (2)
- c.) Should the Grade 12 learners accept the hypothesis as a possible explanation of the results? (1)
- d.) Give a reason for your answer to QUESTION (c) above. (2)

Question 3

- 3.1 The diagram below shows a crossing between a homozygous black mouse and a homozygous white mouse. The F₁-generation was all black.



Use the symbols **B** and **b** for the alleles of fur colour and show diagrammatically a genetic cross between the original black male and white female and between mouse **1** and mouse **3** to show the possible genotypes and phenotypes (F1 and F2). (6)



Question 4

Clones are a group of genetically identical organisms. Explain THREE advantages and THREE disadvantages with reasons of cloning.

Question 5

The ability to roll your tongue to form a tube is passed on from parents to their children. The inability to roll a tongue is a recessive trait. Thabo can roll his tongue but his wife, Octavia cannot. They have four children. The two boys, Keketso and Bongani can roll their tongues. The two girls, Qawekazi and Bongiwe cannot. Use T to represent the character for tongue rolling and t for the inability to roll a tongue.

Use a genetic crossing to supply the genotypes of the parents, Bongani and Qawekazi. Show all your working. (6)



Answers

Exam Questions

Question 1

1.1.1 In a heterozygous condition the dominant allele expresses itself in the phenotype, masking the effect of the recessive allele

OR

When two individuals with pure breeding contrasting characteristics are crossed, the F_1 -generation all display the dominant characteristic

1.1.2 Each characteristic is regulated by two alleles/factors which separate during meiosis so that each gamete contains only one of the alleles/factors

1.2.2 **Complete:** When two individuals with pure breeding (homozygous) contrasting characteristics are crossed, the F_1 generation all display the dominant characteristic.

Incomplete: Neither allele is completely dominant over the other.

Co-dominance: Where both alleles are equally dominant.

1.2.2 Heterozygous – when alleles are different for a particular characteristic

Homozygous – when alleles are identical for a particular characteristic

1.2.3 Phenotype – physical, outward manifestation (appearance) of the genes

Genotype – genetic make-up

1.2.4 Harmful – mutation that cause harm to the organism. Sometimes it could also be lethal – causing death of the organism

Harmless – n mutations that have little or no effect on the organism

Useful – a mutation that gives an organism an advantage over others, thus favouring this organism's chances of survival

1.2.5 Genetic engineering is the deliberate modification or altering of the characteristics of an organism by manipulating its genetic material

Biotechnology is the use of biological processes, organisms, or systems to manufacture products intended to improve the quality of human life.



- 1.3.1 They are cheap and easy to grow.
They have easily discernible characteristics.
They grow fast (so he could have multiple generations in a short amount of time)
Many seeds are formed at a time.
They are easily self- and cross-pollinated.
- 1.3.2 To improve the reliability of his results
- 1.4 :
- a.) Complete
 - b.) Co-dominance
 - c.) Incomplete
 - d.) Incomplete

Question 2

- 2.1.1 Combating heart diseases
Improving intelligence
- 2.1.2 $10/1800 \times 100 = 0,55\%$
- 2.1.3 The gene responsible for producing omega-3 fatty acids is located in the DNA of salmon✓/fresh mackerel/tuna
This gene is cut from the donor organism, inserted into a plasmid of a bacterium
Bacteria replicates to form many copies of the gene
These genes are then inserted into the cells of the zygote/embryo
- 2.1.4 a.) **Support**
Healthier for humans to eat/combating heart disease
Mass production of healthy fat
Improves intelligence
- b.) **Against**
Cultural objection to eat meat from pigs
The success rate is very low
Expensive procedure
No value for vegetarians
Objection to eating any genetically modified food
- 2.2 a.) Genetic engineering is the deliberate modification or altering of the characteristics of an organism by manipulating its genetic material
- b.) Don't know long-term / side effects (on baby)
- 2.3.1
- 2.3.2 a.) **13,4 – 13,6 years**
- b.) Average height of boys and girls✓ of different age groups✓ between ten and eighteen years
- c.) No/not accept/reject
- d.)T The girls are taller than the boys at a younger age/between 10 to 13 years OR
The boys are shorter than the girls at a younger age/between 10 to 13 years OR
The boys are not taller than the girls at all age groups



Question 3

P₁ Phenotype **Black X White**
Genotype **BB X bb**

Meiosis

Gametes/G **B, B X b, b**

Fertilisation

Gametes	B	B
b	Bb	Bb
b	Bb	Bb

1 mark for correct gametes

F₁ Genotype **Bb Bb Bb Bb**
Phenotype **100% Black (heterozygous)**

1 mark for stating P₁ and F₁

1 mark for stating meiosis and fertilisation

P₂ Phenotype **Black X Black**
Genotype **Bb X Bb**

Meiosis

Gametes/G **B, b X B, b**

Fertilisation

Gametes	B	b
B	BB	Bb
b	Bb	bb

1 mark for correct gametes

F₂ Genotype **BB Bb Bb bb**

Phenotype **25% Black (homozygous)**
 50% Black (heterozygous)
 25% White (homozygous)

1 mark for stating P₂ and F₂

1 mark for stating meiosis and fertilisation

Question 4

Advantages of cloning

- Producing individuals with desired traits to eliminate unwanted characteristics
- Better yield to increase the amount of food for a large population
- Resistant to diseases to save on the use of pesticides and herbicides
- Organisms produced in a shorter time to increase yield
- Saving endangered species no need for mating partners/looking for partners
- Producing body parts reducing rejection of transplanted parts
- Produce offspring for organisms that are infertile and cannot have their own offspring
- Reproduction is not seasonally dependent



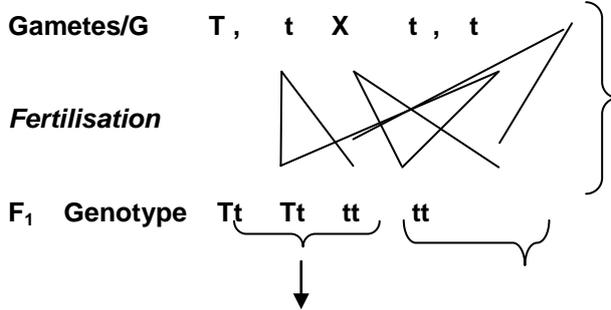
Disadvantages of cloning

- Objection/religious beliefs to interfering with God's/Supreme Being's creation/nature
- Reducing the gene pool by reducing variation/reduces genetic diversity
- Cloned organisms may have developmental/morphological problems and not survive long
- Costly process not all farmers/people/governments can afford it
- May generate more experimental waste causing ethical issues around disposal of waste
- May lead to killing of clones to obtain spare body parts

Question 5

Thabo **Octavia**
P₁ Phenotype Roll Tongue X Non-roller
Genotype Tt X tt

Meiosis



Gametes	T	t
t	Tt	tt
t	Tt	tt

1 mark for correct gametes

50% Rollers 50% Non-rollers

Phenotype

1 mark for stating P₁ and F₁

1 mark for stating meiosis and fertilisation