NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2021

AGRICULTURAL SCIENCES

MARKING GUIDELINES

Time: 3 hours 300 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

SECTION A

QUESTION 1

1.1
1.1.1 Dehiscent dry simple fruit
1.1.2 Accessory fruit
1.1.3 Multiple fruit
1.1.4 Indehiscent dry simple fruit
1.1.5 Compound fruit
1.1.6 Fleshy simple fruit

1.2

1.2.1	A	B	~~C~~	D
1.2.2	~~A~~	B	C	D
1.2.3	A	B	C	~~D~~
1.2.4	A	B	~~C~~	D
1.2.5	A	B	~~C~~	D
1.2.6	A	B	~~C~~	D
1.2.7	~~A~~	B	C	D
1.2.8	A	B	~~C~~	D
1.2.9	A	B	C	~~D~~
1.2.10	~~A~~	B	C	D

1.3

	Only A	**Only B**	**A and B**	**Neither A nor B**
1.3.1		~~X~~		
1.3.2	~~X~~			
1.3.3				~~X~~
1.3.4	~~X~~			
1.3.5		~~X~~		
1.3.6	~~X~~			

1.4
1.4.1 Selection
1.4.2 Equilibrium point/ Market Equilibrium
1.4.3 Monopoly
1.4.4 Integrated Pest Management
1.4.5 Semen
1.4.6 Variation

1.5 1.5.1 Implantation
1.5.2 Leydig
1.5.3 Quarantine/Isolation
1.5.4 Nitrification
1.5.5 Weeds
1.5.6 Soil surveying

1.6 1.6.1 C
1.6.2 E
1.6.3 A
1.6.4 D
1.6.5 F
1.6.6 B

SECTION B

QUESTION 2

2.1 Agricultural pollution and soil surveying:

2.1.1 Definition of agricultural pollution:

- Refers to biotic and abiotic by-products of farming practices that result in contamination or degradation of the environment and harm to ecosystems.

2.1.2 FOUR examples of pollution of the environment through incorrect agricultural practices:

- Use of pesticides in too high concentration.
- Pesticides that are transported by wind.
- Unnecessary use of pesticides.
- Through soil erosion which pollutes water with silt particles.
- Incorrect irrigation leading to acidity or alkalinity of soil.
- Through overgrazing, which causes poisonous plants to increase.
- Planting of alien trees that are known to use too much water.

2.1.3 Explanation of THREE main aims and principles of a soil survey:

- To determine suitability of soil for agricultural purpose.
- Data obtained on soil, climate and topography is used to determine the type of crop or animal to farm with.
- Soil mapping is used to get reliable data on soils.
- Optimal utilisation of land available.

2.2 The technique of asexual reproduction

2.2.1 Identification of the asexual reproduction technique

- Tissue culture

2.2.2 Indication of the most suitable structure or place (environment) where the technique can be practised on a large scale

- Laboratory/ Greenhouse/ controlled environment

2.2.3 TWO factors necessary for the development of the plant:

- Light
- Food/ soluble nutrients
- Water
- Space

2.2.4 TWO advantages of using this technique in agriculture.

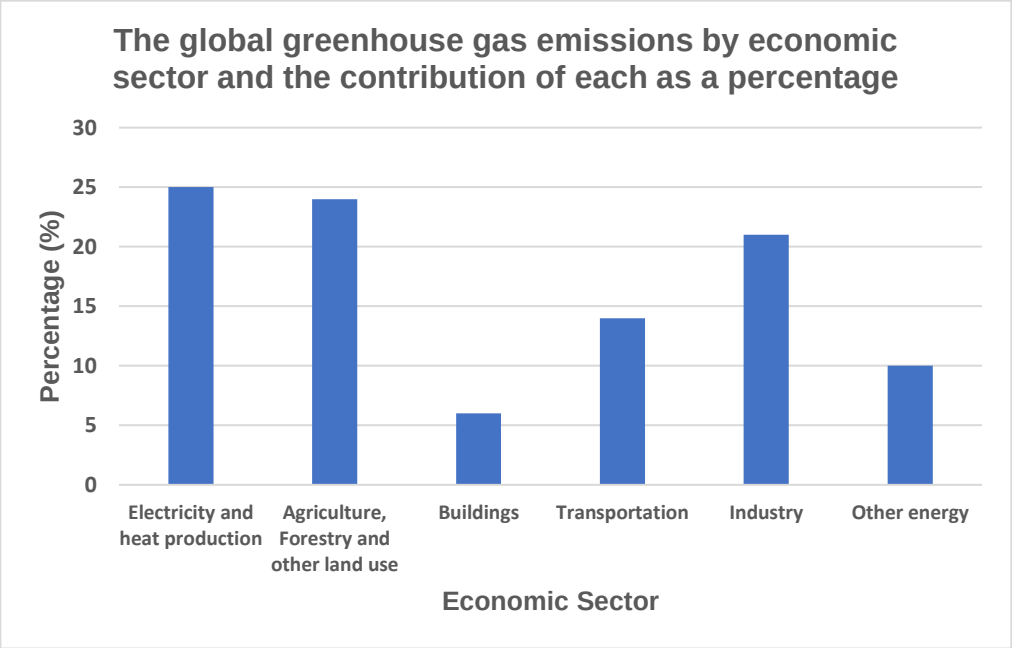
- Identical plants/clones are produced
- Production of many plants within a short space of time
- Production of healthy plants
- Plantlets are protected from harsh environmental factors
- Plantlets are protected from diseases and pests

2.2.5 **The name of a type of chemical that could be added to the solution to promote root growth.**

- Plant hormone
- Hormone
- Rootone

2.3 **Greenhouse effect:**

2.3.1 Bar graph:



Criteria/rubric/marking guidelines

- Correct heading
- X-axis: Correctly calibrated with label (Sources by names)
- X-axis: Correct label (Economic sector)
- Y-axis: Correctly calibrated (Scale)
- Y-axis: Correct label (Percentage)
- Correct unit (%)
- Correct type of graph (Bar graph)
- Correct plotting of bars

2.3.2 **FIVE major causes of the greenhouse effect:**

- Burning of fossil fuels
- Global warming
- Deforestation
- Industrial waste
- Landfills
- Depletion of ozone layer
- Injudicious farming methods
- Smog / Air pollution
- Acidification of water bodies

2.3.3 **Definition of global warming:**
Global warming is the gradual heating of Earth's surface, oceans and atmosphere, mainly caused by human activities – primarily burning of fossil fuels that pump carbon dioxide (CO_2), methane and other greenhouse gases into the atmosphere.

2.3.4 **Description of THREE effects of global warming:**

- **Increase in average temperatures and temperature extremes:** One of the most immediate and obvious effects of global warming is the increase in temperatures around the world.
- **Ecosystems:** Global warming stresses ecosystems through temperature rises, water shortages, increased fire threats, drought, weed and pest invasions, intense storm damage and salt invasion, just to name a few.
- **Species:** Many species are at risk of extinction because of climate change. To survive, plants, animals and birds confronted with climate change have two options: move or adapt. With the speed of climate change we are experiencing, it's often not possible for a species to adapt quickly enough to keep up with their changing environment. And with the amount of habitat destruction, moving is becoming increasingly difficult.
- **Food and farming:** Changes to rainfall patterns, increasingly severe drought, more frequent heat waves, flooding and extreme weather make it more difficult for farmers to graze livestock and grow produce, reducing food availability and making it more expensive to buy.
- **Water:** Reduced rainfall and increasingly severe droughts may lead to water shortages.
- **Coastal erosion:** Rising sea levels and more frequent and intense storm surges will see more erosion of South Africa's coastline, wearing away and inundating community and residential properties.
- **Health:** Increasingly severe and frequent heat waves may lead to death and illness, especially among the elderly. Higher temperatures and humidity could also produce more mosquito-borne diseases.
- **Damage to homes:** Increasingly severe extreme weather events like bushfires, storms, floods, cyclones and coastal erosion, will see increased damage to homes, as well as more costly insurance premiums.
- **Coral bleaching:** Rising temperatures and acidity in our oceans are contributing to extreme coral bleaching events.

QUESTION 3

3.1 The graph of HIV prevalence in South Africa in 2008:

3.1.1 Identification of the South African province with its percentage

(a) **The highest prevalence of HIV in 2008**
KwaZulu Natal 28%

(b) **The lowest HIV prevalence in 2008**
Western Cape 9%

3.1.2 Description of the possible impact of high HIV-AIDS infections on:

(a) **Labour availability on farms**
- There will be labour shortages because HIV-AIDS infections will lead to illness, absenteeism and death.

(b) **Productivity of farm labour**
- Productivity will be low because absenteeism caused by HIV-related illnesses and the loss of labour from AIDS-related deaths may lead to the reduction of the area of land under cultivation and to declining yields resulting in reduced food production and food insecurity / Planning will also be difficult when rate of absenteeism is high due to HIV-related illnesses or deaths.

3.1.3 THREE measures to limit the impact of HIV-AIDS on agricultural labour force:
- Farmers may organise awareness programmes (Education) for farm workers on different health-related matters.
- Working together with local health clinics, farmers can organise that condoms be readily available to farm workers.
- Farmers can work together with health care institutions to organise mobile clinics where infected farm workers can be supplied with supplements and ARVs.
- Mobile clinics working with farmers can encourage good values to families of farm workers and discourage multiple partners.
- Establishment of support groups for affected workers.

3.2 The table showing diseases, pathogens, symptoms and types of animal:

3.2.1 Complete the table

A: Inflammation in the udder, drop in milk production
B: Newcastle disease (NCD)
C: Protozoa
D: Wool sheep

3.2.2 Identification of a disease in the table that affects only dairy cows.

Mastitis

3.3 **Farm business management is a key production factor that makes efficient and effective use of the other three production factors namely:**

- Land
- Labour
- Capital

3.4 **Vegetable farm in North-West:**

3.4.1 **Completion of the income statement table:**

INCOME		**EXPENDITURE**	
TRANSACTION	**AMOUNT**	**TRANSACTION**	**AMOUNT**
• Sale of vegetables • Sale of compost	R207 500,00 R38 000,00	• Wages of workers • Loan repayment • Pest control costs • Other costs	R118 400,00 R19 100,00 R49 222,00 R169 322,00
TOTAL INCOME	**R245 500,00**	**TOTAL EXPENSES**	**R356 044, 00**

3.4.2 **Determining viability of the business:**

- Profit = Total income – Total expenditure
  = R245 500,00 – R356 044,00(4)
  = – R110 544,00 (–) **OR** R110 544,00 (Loss)

- Therefore, the loss shows that the business is **not viable**.

3.4.3 **Explanation of how the risk management strategies can help the farmer to improve the income of the farm:**

(a) On-farm processing or value adding

- The farmer can increase income by processing and packaging the vegetables on the farm in order to avoid risks of low market prices.

(b) Hedging

- The farmer can enter into future contracts (agreement to buy or sell a certain quantity of product at a particular price on an agreed date) to reduce the impact of future changes in market prices.

3.4.4 **Definition of terms**:

(a) **Overhead costs:** general expenses in a farming business not related to one particular enterprise.

(b) **Fixed costs:** are the expenses in a farming business that do not change with the level of production.

(c) **Variable costs:** are the expenses in a farming business that vary with the level of production.

QUESTION 4

4.1 The concept of genetic modification

4.1.1 Identification of the technique of genetic modification
Agrobacterium tumefaciens OR Bacterial carrier

4.1.2 TWO other techniques of genetic modification used in plants
- Gene gun / Biolistics
- Electroporation
- Microinjection

4.1.3 TWO aims of genetic modification in plants
- Improving crop yield
- Easy management of pests, diseases and weeds
- Improving tolerance to environmental conditions
- Increasing nutritional value of crops
- Producing pharmaceutical crops / Biofortification

4.1.4 Differentiation between genetics and heredity

Genetics
It is the study of how genes are transferred from parents to offspring. or Study of heredity.
Heredity
It is the transfer of characteristics from parents to their offspring.

4.2 The diagram of different sperm cells

4.2.1 Identification
E

4.2.2 Naming of the process
Spermatogenesis

4.2.3 Explanation of how sperm cells A and G can cause infertility in a bull
A: The sperm cannot move to the point of fertilisation because it has no tail.
G: The sperm cannot fertilise the egg cell because it has no nucleus.

4.3 Small fruit farmer who wants to plant an orchard of plum trees.

4.3.1 Possible reason for the inclusion of cultivar B into this orchard.
- Cross pollination / Cultivar B is used to supply pollen for cross-pollination with Cultivar A

4.3.2 Justification of the even distribution or placement of these trees from cultivar B in this orchard.
- Cultivar B trees are placed in such a way that they are close to Cultivar A trees

4.3.3 **Indication of TWO possible reasons for placing beehives in the orchard.**

- Insects (bees) for cross pollination
- The production of honey as a secondary product

4.4 **The poisonous chemical (DDT) was used in the past as an effective pesticide in agriculture. It was also used by the Department of Health.**

4.4.1 **Name of the insect**

- Mosquito

4.4.2 **TWO characteristics of DDT:**

- It is non-biodegradable / does not fully decompose in the soil (plant)
- It kills non-target organisms and helpful species like bees
- It is absorbed in the blood system of the organisms
- DDT disturbs the whole ecosystem / negatively affects the food chain

4.4.3 **TWO disadvantages of injudicious use of pesticides:**

- Pollution of the soil
- Pollution of water resources
- Beneficial organisms are poisoned in the ecosystem
- Food for human and animal consumption may be contaminated with poison

4.5 **Stages of mating or copulation.**
Re-arranged the stages of mating

- erection of the penis
- mounting
- gaining intromission into the vagina
- ejaculation of semen into vagina

4.6 4.6.1 **Farming system**

- Precision farming

4.6.2 **Reasons for the use of computers and global satellites**

- To measure the correct environmental conditions.
- To determine if crops are growing at maximum efficiency.

4.6.3 (a) **Geographic Positioning System (GPS)**

- To determine a precise position in a farming field or a cultivated area.

(b) **Geographic Information System**

- Computers capture, manage and analyse special data related to crop productivity and field inputs. / It makes sense of all the available data.

4.7 Oestrus cycle graph

4.7.1 Name of the hormone labelled C

- Progesterone

4.7.2 Indication of the stage of oestrus

- Di-oestrus

Reason

- It is the longest / it lasts longer
- High levels of progesterone

4.7.3 Process represented by A

- Ovulation

4.7.4 TWO visible signs of a cow on oestrus

- Vulva is swollen with reddish mucus membranes
- Mucus strings visible from the vulva
- Jumps on other cows / allows the cows to jump on her
- Scratch marks and dirt on the side and back
- Allows mating with the bull

QUESTION 5

5.1 Representation of a cross between a black cow and a white bull

5.1.1 Identification of the genotype

(a) Black parent cow – Bb

(b) White parent bull – bb

5.1.2 Determination of the F_2 offspring

Phenotype – white

5.1.3 Punnet square

♂ \ ♀	**B**	**b**
b	**Bb**	**bb**
b	**Bb**	**bb**

- 1 mark for male gametes
- 1 mark for female gametes
- 4 marks for offspring
- 1 mark for Punnett square with information

5.2 5.2.1 Crossing parents with TWO characteristics Identification of the crossing

Dihybrid cross

5.2.2 Determination of characteristics received by each offspring

- Offspring 1 – Colour
- Offspring 2 – Shape
- Offspring 3 – Shape

5.2.3 Indication of the dominant characteristics

- Square shape
- White colour

5.2.4 Indication of the percentage of genes received

50% / each received 50% genes from both parents.

5.3 The picture for the flower of a plant
Relating parts of the flower to functions

5.3.1 A

5.3.2 B

5.3.3 I

5.3.4 H

5.3.5 E

5.3.6 G / J

5.4 Soil degradation

5.4.1 Identification of the main challenge of the soil

- Soil degradation / Soil erosion

5.4.2 TWO physical causes of the challenge identified in Question 4.5.1

- Water / Floods
- Wind
- Glacier / Moving Ice

5.4.3 Explanation of THREE ways in which the farmer can improve the condition of the soil

- **Green manure:** Helps to maintain the organic matter status of arable soil. Stable organic matter as well as nitrogen intake for the following crop are obtained after degradation of the plant by the soil's microorganisms (microbial or enzymatic activity).
- **Crop rotation:** Different seedings have different root systems, either shallow or deep. They penetrate soils on alternative levels, thus improving soil porosity. Also, green leys cover lands and protect them from being exposed directly to winds and rains that destroy the land surface.
- **Agro-forestry:** The forest canopy, roots and leaf litter all have a role in controlling soil erosion. Water logging: Through water removal, established trees can substantially reduce water logging in their immediate area, which may result in improved land uses, e.g. pasture or crop.
- **No-till / Reduced tillage:** helps retain organic matter, nutrients and water within the soil, with the overall result being healthier soil structure for more prolific crops.
- **Vegetative filter strips:** one way of controlling erosion rates keeping soil in the field rather than moving off site VFSs are created areas of vegetation designed to remove sediment and other pollutants from water runoff. Intercept surface water runoff and trap as much as 75–100% of sediment • Capture nutrients in runoff by plant uptake and adsorption to soil particles • Promote degradation and/or transformation of pollutants • Remove over 60% of certain pathogens.

5.5 Matching the letter (A–F) of the equipment to the function

5.5.1 A

5.5.2 D

5.5.3 E

5.5.4 F

5.5.5 B

5.5.6 C

5.6 Scenario on breeding system

5.6.1 Identification of the animal breeding system applied by Farmer B

- Crossbreeding

Reason

- Crossing of two different breeds

5.6.2 TWO advantages of outcrossing

- The least likely system to produce any problems.
- Offspring will carry the traits / characteristics of both parents.
- Improve genetic diversity / new blood line is introduced.

5.6.3 TWO reasons why the old and non-fertile cows are sold

- Reached the end of their production cycle/not productive
- Efficiency by saving on nutrition
- Improve the fertility of the herd
- More economical for the farmer

5.6.4 Breeding system used by Farmer B with his own bulls

Line / in breeding

SECTION C

QUESTION 6

STATEMENT: One of the main requirements for successful artificial insemination is that the semen must be healthy, viable and disease free. This includes proper storage, thawing and preparation for insemination.

BASIC REQUIREMENTS FOR SEMEN COLLECTION:

- **The learners should discuss four of the following**

1. **Legislation related requirements**
   - Collection of semen is regulated by the Livestock Improvement Act no. 25 of 1977.
   - Semen collection is normally done at specialised AI centres.
   - Semen is allowed to be collected from licensed bulls for AI purposes.
   - Only veterinary surgeon, registered semen collector, owner or full-time employee of owner are allowed to collect semen.

2. **Place where the procedure will be done**
   - Must be as close as possible to the laboratory where the semen will be analysed.
   - The floor space must not be slippery to avoid injury to handler and helpers.
   - There should be enough floor space to work efficiently.

3. **Equipment**
   - should be readily available when needed.
   - must be sterilised and dried well before use to prevent spread of bacteria and infections.
   - a tube to measure amount of semen released must be available.
   - collecting vial must be warmed to prevent cold shock to sperm cells.
   - immediately after collection the vial must be placed in a warm bath or thermos flask at about 32 °C.

4. **Animal handlers**
   - Animal handler should be a qualified, trained person.
   - Animal handler should be sensitive about hygiene.
   - There should be enough handlers available.
   - Animals should be handled as calmly as possible.
   - Never handle the penis directly by hand to avoid injury to the animal.

5. **Availability of a teaser bull**
   - Teaser bull must be available.
   - The teaser bull should have a calm disposition.

6. **Availability of a bull**
   - The animal must be cleaned.
   - Cut hair around the prepuce to prevent contamination.

The learners should discuss any of the TWO methods of collecting semen:

1. **First method: Use of artificial vagina**
   - This is the ideal method of semen collection used which is safe for sire and the collector.
   - The bull must be taught how to use the artificial vagina.
   - A live teaser animal or dummy can be used for mounting.
   - It uses thermal and mechanical stimulation to stimulate ejaculation.
   - To collect semen bull is allowed to mount and the penis is diverted into the artificial vagina where it will ejaculate.
   - Semen is only collected 3 to 4 times a week from the same bull.
   - One ejaculate has a volume of 4 ml–8 ml with about 1 300 million sperm cells per millilitre, but only 5–10 million sperm cells are needed for a successful AI.

2. **Second method: By electro-stimulation method**
   - It involves applying a series of short, low-voltage pulses of current into the rectum, where pelvic nerves are involved in the ejaculatory response.
   - It is important to have the rhythmic stimulation, the probe should press against the ampulla.
   - The probe should be placed correctly to avoid emission of semen only without the bull showing erection.
   - The procedure seems unpleasant, but it does not cause much distress in bulls.
   - This method is usually reserved for lame, old bulls and bulls that have temporarily lost their desire to serve the artificial vagina.

CHARACTERISTICS OF GOOD-QUALITY SEMEN (SEMEN EVALUATION)

- **Learners should mention and discuss any of the following:**

1. **Good-quality semen must be viable**
   - Meaning that semen must be alive and maintain motility after storage.
   - Semen of good quality contains less than 15% dead sperm cells and at least 80% should show mobility and only 20% should show abnormalities.
   - Diseases and age of a bull are factors to be closely monitored as they affect quality of sperm cells.
   - Good-quality semen is the product of good nutrition and suitable environmental conditions.

2. **Colour of good quality semen**
   - Good quality semen is opaque and milky white to yellowish in colour.
   - It is not good if the colour is greyish: that indicates infection, reddish means presence of fresh blood and dark brown semen indicates presence of old blood.
   - White flakes may indicate pus and infection in male reproductive tract.
   - Good quality semen is very concentrated, thick and sticky.
   - Thickness gives indication of sperm count; poor-quality sperm looks like watered-down milk.
   - Ejaculates with abnormal colour should be discarded.

3. **Structure of a good-quality semen**
   - Semen should have a normal acrosome, middle piece and tail.
   - The ejaculate should have at least 80% normal sperm cell.

4. **Volume of good-quality semen**
   - One ejaculate has a volume of 4 ml–8 ml with about 1 300 million sperm cells per millilitre, but only 5–10 million sperm cells are needed for a successful AI.

5. **Characteristic smell of good-quality semen**
   - Good-quality semen should have no odour as this may indicate urine in the semen or infection.
   - Good-quality semen smells like fresh milk.

6. **Correct pH of a good-quality semen**
   - Good-quality semen should have a pH between 6,4 to 6,9 when collected.
   - If semen has a pH higher than 6,9 it is of poor quality.

THE LEARNERS SHOULD MENTION AND DISCUSS DILUTANTS AND FUNCTIONS OF SUCH DILUTANTS

1. **Dilutants**
   - Once semen has been collected, it needs to be preserved for later use in AI.
   - This is done by treating semen with a dilutant substance as soon as possible after collection.
   - The commonly used dilutant is TRIS-fructose-egg-yolk (TFEY) extender.
   - The dilutants contain egg yolk, milk, glycerol, buffers and a small quantity of antibiotics.
   - The aim of extending semen is to increase the number of females that can be inseminated with a single collection.
   - The dilutants also provides nutrients for sperm.
   - The dilutants creates a safe environment for the sperm to survive in so that fertility is maximised.
   - Dilutants increase the volume of the semen.

2. **Functions of dilutants**
   - Buffers (sodium citrate or egg yolk) control the pH of the semen to remain between 6,7 and 7,0 during storage.
   - Lipids (skimmed milk and egg yolk) protect sperm cells from temperature changes such as cold shock.
   - Nutrients (fructose and glucose) provide energy for the sperm cells.
   - Antibiotics (penicillin and streptomycin) protect the sperm from bacterial growth.
   - Glycerol is used as a cryo-protective agent that protects the sperm from the lethal effects of freezing and prevents crystallisation of water within the sperm cells.
   - Dilutants increase the volume of the semen so that it can be used many times.
   - Dilutants provide correct osmotic and electrolyte pressure.
   - Dilutants increase the viability of sperm cells.

THE LEARNERS SHOULD DISCUSS THE BASIC REQUIREMENTS FOR STORAGE OF COLLECTED SEMEN

- After collection, semen is placed in a dry-block or water bath at 32 °C–35 °C during the evaluation period.
- Antibiotics are added to the neat semen and allowed to stand for 3–5 minutes.
- The semen is then diluted for freezing and storage.
- If semen is stored for short periods, it can be stored at 5 °C.
- If semen is stored for longer time, it is placed in straws of 0,2 ml and 0,5 ml and frozen in liquid nitrogen at –196 °C.
- When required, the sperm is thawed (straws placed in water between 32 °C–35 °C for about 15 seconds.

Total: 300 marks