Form Six Mock Examination 2018-2019

DSE BIOLOGY PAPER 2

Date: 14th Feb. 2019
11:25 am – 12:25 am (1 hour)
This paper must be answered in English

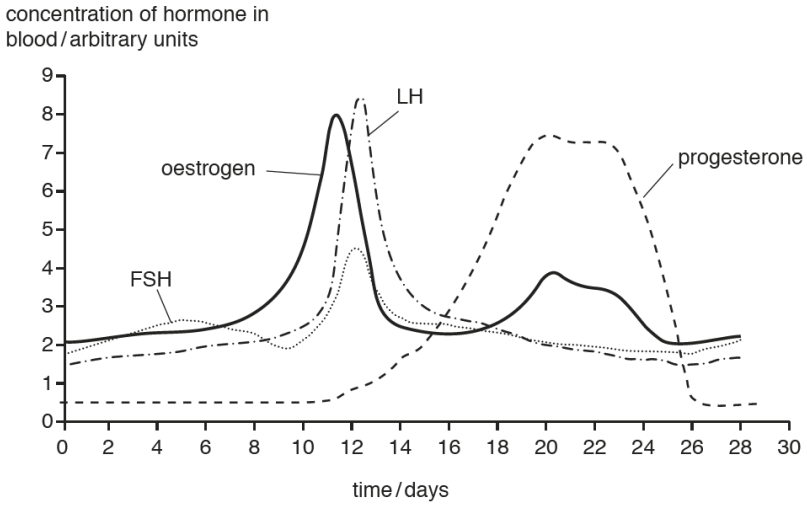
INSTRUCTIONS

1. There are **TWO** sections, A and B in this Paper. Attempt **ALL** questions in these **TWO** sections**.**
2. Write your answers in the Answer Book provided. Start each question (not part of a question) on a new page.
3. Present your answers in paragraphs wherever appropriate.
4. Illustrate your answers with diagrams wherever appropriate.
5. The diagrams in this paper are **NOT** necessarily drawn to scale.

Section A Human Physiology: Regulation and Control

Answer **ALL** questions

1. The figure below shows the concentration of four hormones in a woman's blood during one menstrual cycle.



(a) With reference to the above figure, suggest evidence that

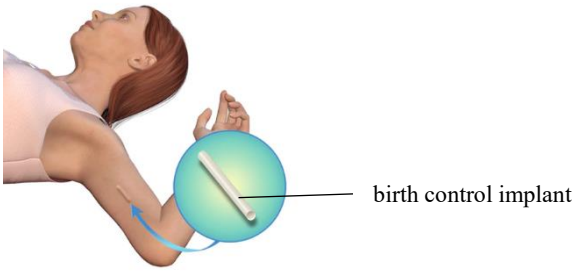
(i) oestrogen causes the increase in LH secretion at around day 12. (1 mark)

LH peaks after oestrogen peaks / oestrogen peaks just before LH peaks

(ii) the woman did not become pregnant during this cycle. (1 mark)

Level of progesterone falls at around day 23 / towards the end of cycle.

(b) Some women have a birth control implant inserted under the skin. This releases progesterone into the blood and can last for up to three years.



(i) Explain how such implant works to prevent pregnancy. (5 marks)

High level of progesterone act on pituitary gland (1) to inhibit FSH and LH secretion (1)
Low level of FSH not sufficient to stimulate follicular development (1)
Low level of LH not sufficient to stimulate ovulation (1)
As a result, fertilization cannot take place (1)

(ii) Suggest ***one*** advantage of using the birth control implant over an oral contraceptive. (1 mark)

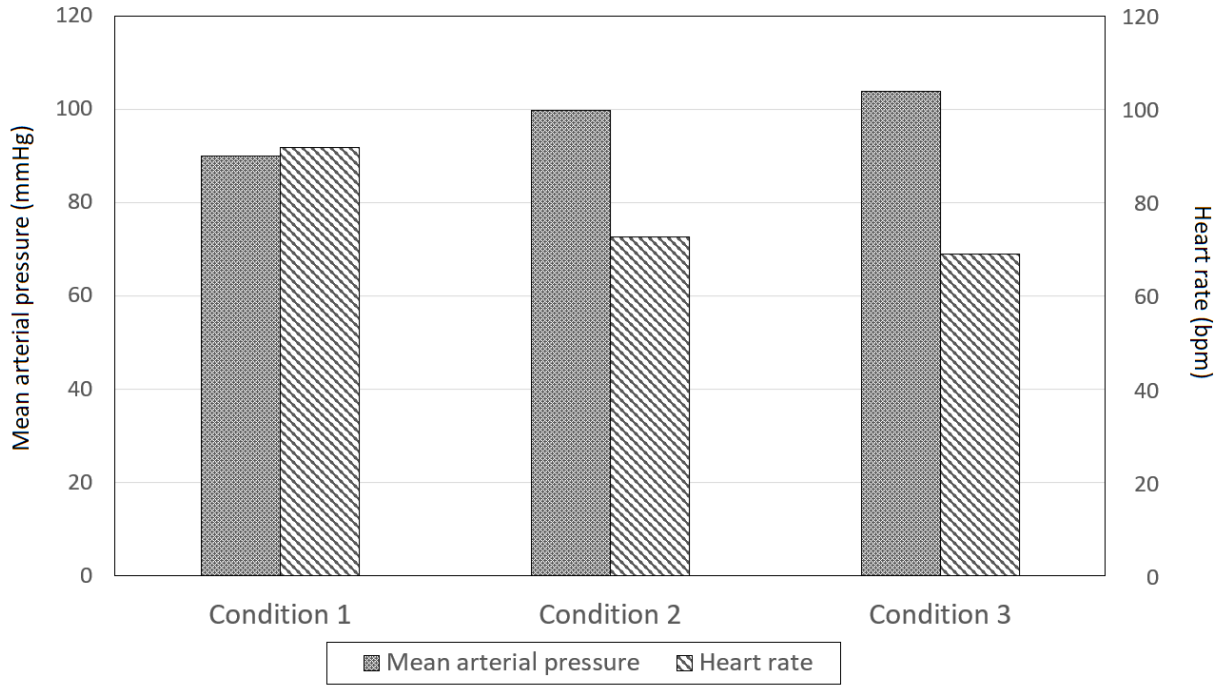
Will not forget to take pills / does not have to be taken daily / other reasonable answers

Total: 8 marks

2. Diving response is a set of reflexes activated in human when the face is in contact with cold water. It causes breath holding, changes in heart rate and blood pressure. Vasoconstriction of arterioles near skin surface will cause an increase in arterial blood pressure.

In a study, the diving responses under 3 different conditions were investigated:
Condition 1 – breathing in air
Condition 2 – face immersion in cold water
Condition 3 – whole body immersion in cold water (diving)

The mean arterial pressure and heart rate were measured and results are shown in the graph below:



(a) With reference to the experimental results, state the effect of immersion (conditions 2 and 3) on mean arterial pressure and their effects on heart rate. (1 mark)
Immersion increases mean arterial pressure while decreases heart rate (1)

(b) Compare the change in mean arterial blood pressure of subjects in condition 2 and 3. Suggest reasons for such difference. (3 marks)
The increase in mean arterial blood pressure is greater when their bodies were immerse in cold water. (1)
Larger contact surface area with cold water when whole body immersed → greater heat loss by conduction/convection/radiation from skin to surroundings (1)
greater degree of vasoconstriction (1) → greater increase in mean arterial blood pressure

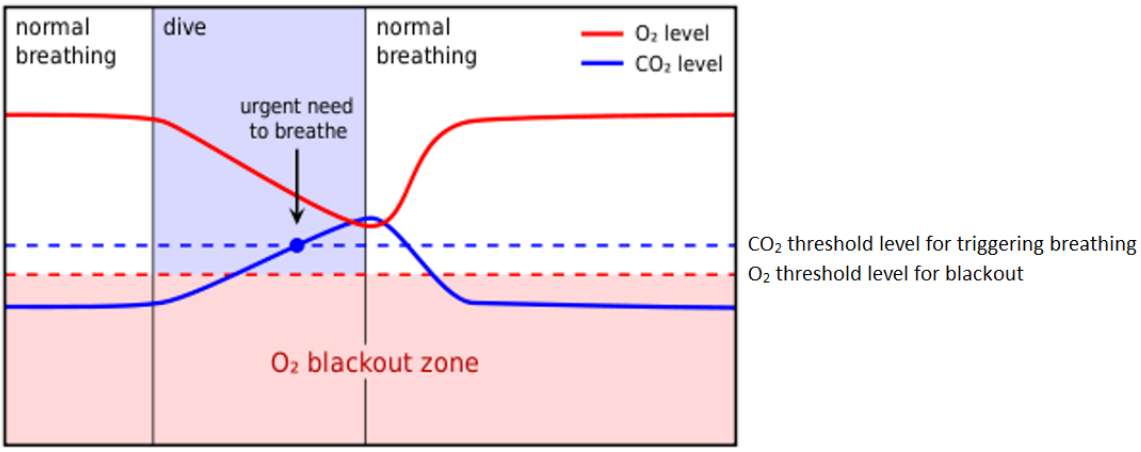
(c) After diving, the subjects returned to water surface and breathed rapidly and heavily. Describe the nervous coordination leading to this response. (5 marks)

- Carbon dioxide produced during respiration not removed while holding breath → accumulate in blood
- Increase in carbon dioxide level detected by chemoreceptors in medulla / carotid / aortic bodies
- Respiratory centre in medulla oblongata stimulated
- Send more nerve impulses to respiratory muscles
- Diaphragm and intercostal muscles contract more frequently and forcefully

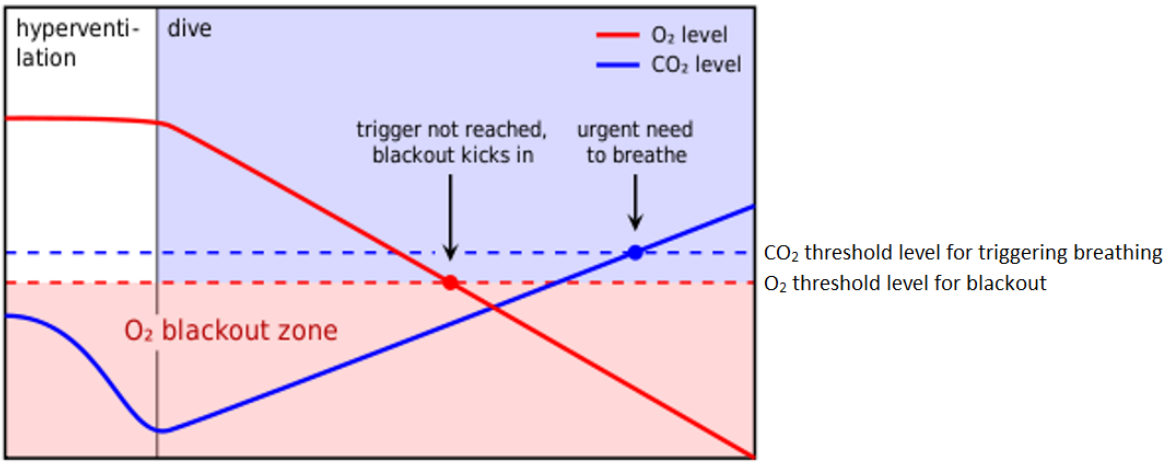
Sometimes, diver may hyperventilate (taking many voluntary deep breaths in rapid succession) before diving as this could increase their time of diving. However, this practice is very dangerous as blackout may occur, during which the diver will lose consciousness in water and drown.

The diagrams below show the changes in oxygen and carbon dioxide level in blood with and without hyperventilation before diving:

Normal dive



Hyperventilation before dive



(d) Explain why hyperventilation would increase the diver's risk of blackout. (3 marks)

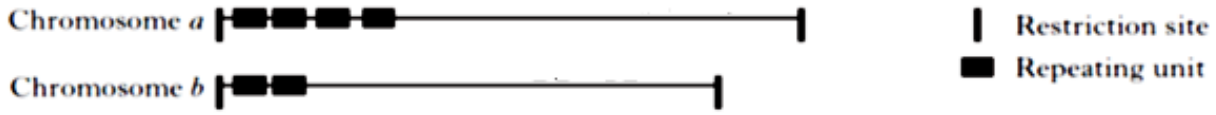
- lowers the carbon dioxide level in blood before diving (1)
- oxygen level continue to decrease as cells consume oxygen by respiration (1)
- increased risk of reaching oxygen blackout threshold before carbon dioxide accumulates to a level high enough to trigger the urge to breath (1)

Total 20 marks

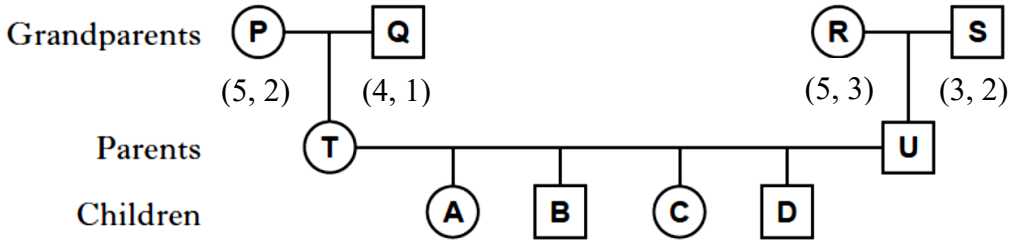
Section B Biotechnology

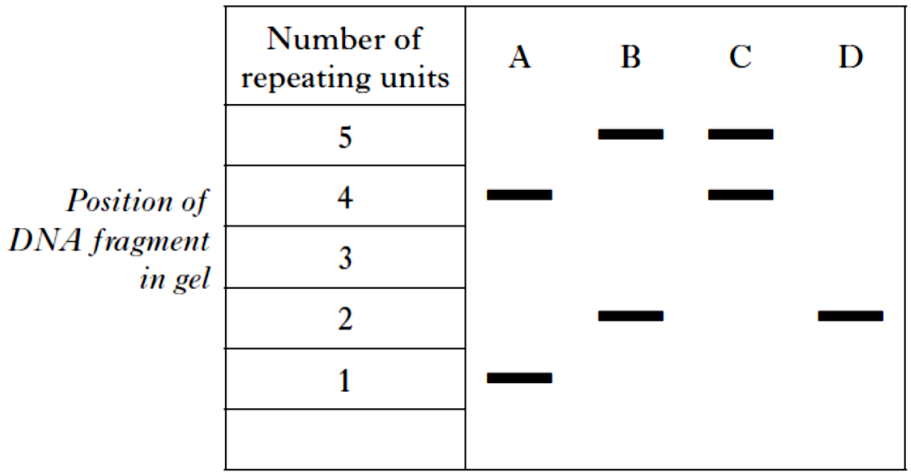
Answer **ALL** questions.

3.(a) Fragments of DNA between restriction sites can vary in length depending on the number of repeating units present. DNA fingerprinting can be used to identify the number of repeating units between the restriction sites on each chromosome.
The diagram below shows fragments from a pair of homologous chromosomes for an individual with four repeating units on one chromosome and two on the other chromosome. The genotype for this individual at this locus is described as (4, 2).



Orphans (A, B, C, D) from a war zone, believed to be from the same family, were being relocated back to grandparents. DNA fingerprinting was used to check their family tree. The results are shown below.





(i) Explain why only one DNA band is formed for child D. (1 mark)

Child D has two copies of fragment with 2 repeating units / inherit fragment size 2 from both parents or grandparents / both alleles or genes have 2 repeating units / has two chromosomes of chromosome b.

(ii) Based on the information given, deduce, with reasons, which child is not biologically related to both pairs of grandparents. (2 marks)

Child A (1)
A has 4 and 1 repeating units on the two chromosomes respectively / A's genotype for this locus is 4,1, grandparents R, S do not have 4 or 1 repeating units
OR
A does not have 5, 3 or 2 repeating units, so not related to P, R and S whom have 5, 3, 2 repeating units (1)

(iii) Other than parentage testing, scientists also use DNA fingerprinting to identify the evolutionary relationship among different groups of living organisms. What is the assumption involved in this application of DNA fingerprinting? (1 mark)
It is assumed that the closer the evolutionary relationship of two groups of organisms, the more bands they have in common in their DNA fingerprints. (1)

(iv) Polymerase chain reaction (PCR) is used to amplify DNA for DNA fingerprinting. Both PCR and DNA replication in human require primers to start the processes. Suggest two differences between DNA replication in humans and PCR. (2 marks)

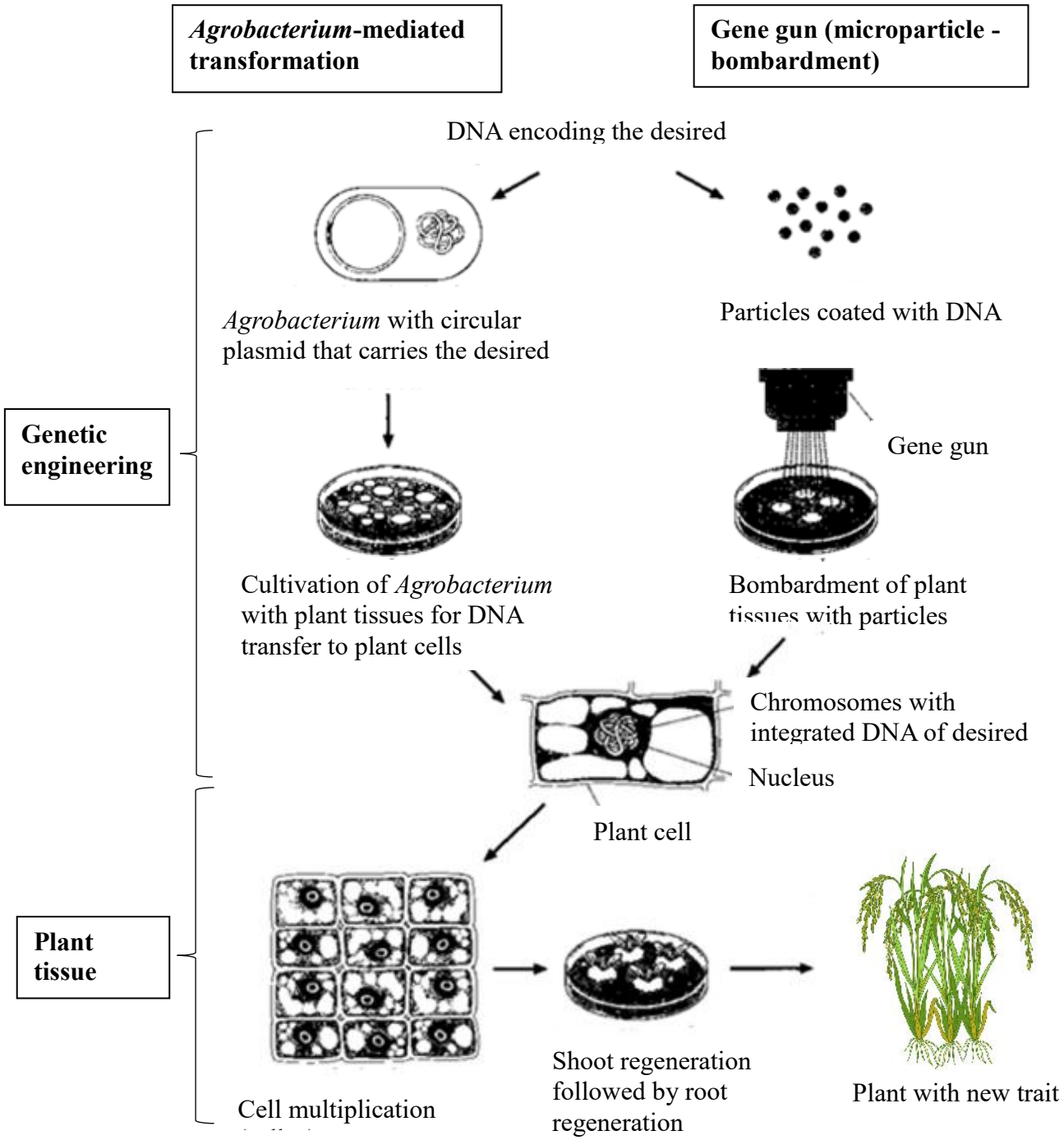
DNA replication in humans	**PCR**
occurs within cells	occurs outside cells
double-stranded DNA separated by enzymes	double-stranded DNA separated by heat
requires human DNA polymerase which works at body temperature	requires heat-stable DNA polymerase

(v) Explain why short tandem repeat (STR) profiling, compare with restriction fragment length polymorphism (RFLP) analysis, is a more commonly used method for DNA fingerprinting nowadays. (3 marks)

STR does not require DNA hybridization, no radioactive probes are needed, is a faster method. (1)
It requires relatively small amount of DNA samples as it is often coupled with PCR. (1)

It can work even with partially degraded DNA. (1)

(b) In 1990s, scientists successfully transferred the genes coding for β-carotene from maize and a soil bacteria to rice plants so as to develop rice that produces β-carotene, which is a precursor of vitamin A. The genetically modified (GM) rice produced is known as golden rice due to its distinctive yellow colour. The diagram below shows the procedures of two methods, the *Agrobacterium* - mediated transformation and the gene gun method, by which the golden rice can be produced.



(i) Shoot apical bud is usually used for tissue culture. Explain why apical tissue is suitable for tissue culture. (3 marks)

Apical tissue contains meristematic cells (1)

Meristematic cells are
active dividing cells capable of rapid cell division to develop into new plants(1) /
undifferentiated cells, so that they can be induced to differentiate into new tissues or plants (1) /
usually free of disease-carrying organisms, so that the plants produced have a higher chance to be disease-free (1) (any 2, 2m)

(ii) Plant tissue culture is applied in the production of golden rice after genetic engineering. Explain two advantages of using plant tissue culture in the production of golden rice. (4 marks)

It ensures all GM rice plants produced carry the inserted gene / all the plants are the same with the desired trait (1)
as mitotic cell division is involved (1)

A large number of GM rice plants can be produced (1) because large number of cells inserted with the target genes can be formed which then develop into the GM rice plants (1)

A fast method (1) to propagate the plants as pollination, fertilization, seed and fruit dispersal are not involved (1)

The GM rice plants produced are free of disease-causing microorganisms or have lower chance of transmission of diseases (1) as they are cultivated under sterile condition (1)

(iii) *Agrobacterium* is known as a natural genetic engineer. Explain why it is widely used in modifying plants. (2 marks)

It contains a plasmid which can be used to carry the target gene. (1)
It can naturally infect plants. (1)

(iv) Compared with *Agrobacterium*-mediated transformation, suggest one advantage and one disadvantage of using gene gun for transforming plants. (2 marks)

Advantages: (any 1, 1 mark)
- it can introduce the target gene to the plant cells directly
- it does not need to produce genetically modified bacteria / vector
- no *Agrobacterium* 'overgrowth' problem, *Agrobacterium* may grow out of control and kill the explants.
- *Agrobacterium* transformation needs GMO safety labs and culture rooms, while gene gun requires none.
- as no antibiotic resistance genes are involved in making the GM plants, when human consume the food, the chance of transferring these genes to some pathogenic bacteria in human body and produce antibiotic-resistant “superbugs” can be lower

Disadvantages: (any 1, 1 mark)
- It may causes damage to the tissues

- Uncontrolled multiple copy of genes may be inserted while using bacterium as a transfer vector will produce more single copy transgenic events.
  Gene gun may lead to multiple site insertion, thus the DNA may be transformed into whatever genomes are present in the cell, be they nuclear, mitochondrial, plasmid or any others, in any combination.
- The genes inserted may be overexpressed or inappropriately expressed when it is inserted multiple times in either the same or different locations of the genome, resulting to unknown problems

Total 20 marks

END OF PAPER