UNIVERSITY OF SWAZILAND

MAIN EXAMINATION PAPER: MAY 2013

TITLE OF PAPER: APPLIED BIOLOGY

COURSE CODE: B405

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. THIS PAPER IS DIVIDED INTO FOUR SECTIONS
2. USE SEPARATE ANSWER BOOKLETS SECTIONS A AND B.
3. ANSWERS TO SECTIONS C AND D MUST BE IN ONE ANSWER BOOKLET
4. ANSWER A TOTAL OF FOUR QUESTIONS, CHOOSING ONE QUESTION FROM EACH SECTION.
5. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS
6. ILLUSTRATE YOUR ANSWER WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE

SPECIAL REQUIREMENTS: NONE

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATORS

SECTION A

Answer **one** question from this section.

Question 1

(a) If r = 2.5 per year for a polytic pathogen, how much disease would you expect to observe? (2 marks)

(b) Use Van de Plank's equation to state the principles behind plant disease control. (4 marks)

(c) Write an essay on monocyclic and polycyclic diseases. (9 marks)

(d) Make a clear distinction between horizontal and vertical resistance in plants. (10 marks)

[TOTAL MARKS = 25]

Question 2

Write an essay on emerging and re-emerging diseases. (25 marks)

[TOTAL MARKS = 25]

SECTION B

Answer **one** question from this section.

Question 3

Conservation efforts could be directed at many, if not all, levels of biological organization, yet most of these efforts focus on species.

(a) Explain why this is the case and give problems and benefits to this approach. (15 marks)

(b) If you were in charge of conservation efforts, what other level of biological organization, apart from species, would you focus on and why? (10 marks)

[TOTAL MARKS = 25]

Question 4

Suppose you are a government official in charge of *Swaziland Agency for Protected Areas & Biodiversity Conservation* and your annual budget allocation is E20 Million. Provide practical and ecologically sound justifications for the percentage of your budget that you would allocate to the following missions:

(a) Conducting species inventories, (7 marks)

(b) Determining species and ecosystems at risk, (6 marks)

(c) Studying mechanisms of extinction for particular groups of species, (6 marks)

(d) Reserve design studies. (6 marks)

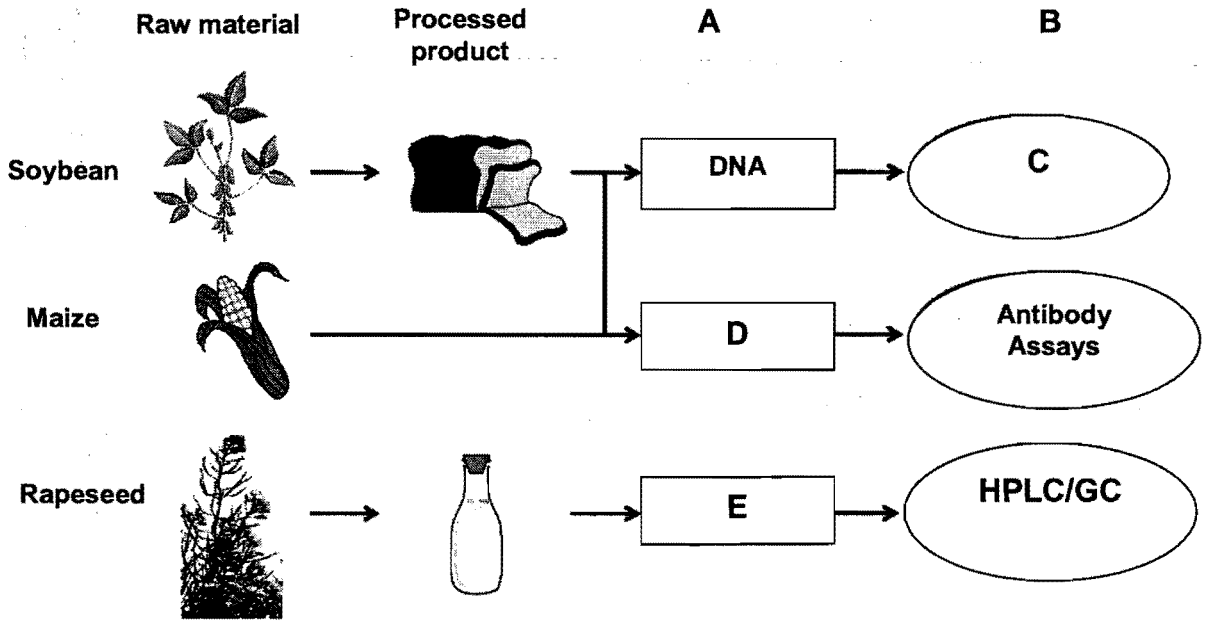
[TOTAL MARKS = 25]

SECTION C

Answer **one** question from this section.

Question 5

(a) Detection and screening of GM food may involve molecular, biochemical and analytical methods. Shown below is a diagram with typical crops that can be genetically modified.



Identify the missing labels **A, B, C, D** and **E**. (5 marks)

(b) DNA extraction is the first thing a molecular biologist should do before performing any experiment on a biological sample. Explain why one would want to extract DNA. In the extraction protocol, which can be CTAB-based, Phenol-Chloroform-based or Kit-based, choose any five chemical reagents and briefly explain their role during DNA extraction. (5 marks)

(c) Explain the difference between a genomic DNA and a cDNA library. (5 marks)

(d) Given an inoculum of a bacterial species X, outline the construction of a typical cDNA library using this inoculum as a starting material. (10 marks)

[TOTAL MARKS = 25]

Question 6

(a) Explain what you understand by Bioinformatics. (3 marks)

(b) Explain the difference between BLASTP and BLASTN, and when would one want to do a BLAST search? (4 marks)

(c) You have just isolated an unknown strain of bacteria. Explain how you would attempt to identify the tentative genus it may belong to using molecular biology and bioinformatics techniques of your choosing. (18 marks)

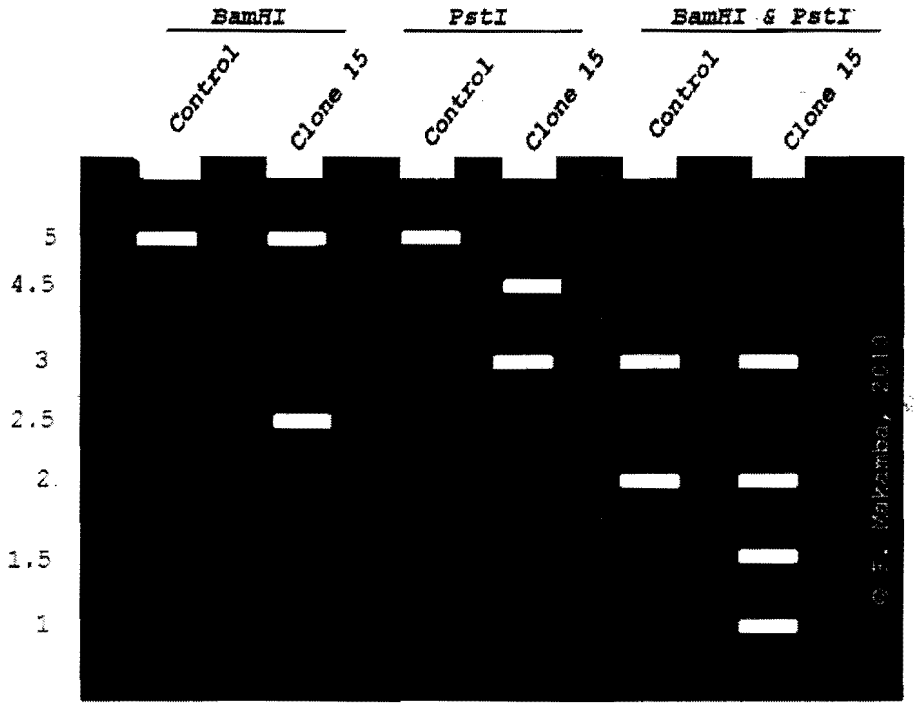
[TOTAL MARKS = 25]

SECTION D

Answer **one** question from this section.

Question 7

(a) A circular bacterial plasmid (pBP1) has a single *BamH*I restriction-enzyme site in the middle of a tetracycline-resistance gene (*tet*^{R}). The genomic DNA of a fruit fly *(Drosophila)* is digested with *BamH*I, and a library is made in pBP1. Probing reveals that clone 15 contains a specific *Drosophila* gene of interest. Clone 15 is studied by restriction analysis with *BamH*I and another restriction enzyme, *Pst*I. The ethidium bromide-stained electrophoretogram shows bands as illustrated in the diagram below (the control was plasmid pBP1 without an insert. The sizes of the bands (in kilobase pairs) are shown alongside. (**Note:** Circular molecules do not give intense bands on this type of gel, so you can assume that all bands represent linear molecules).



(i) Draw restriction maps for plasmid pBP1 with and without the insert, showing the sites of the target sequences and the approximate position of the *tet*^{R} gene. (Show your reasoning) (6 marks)

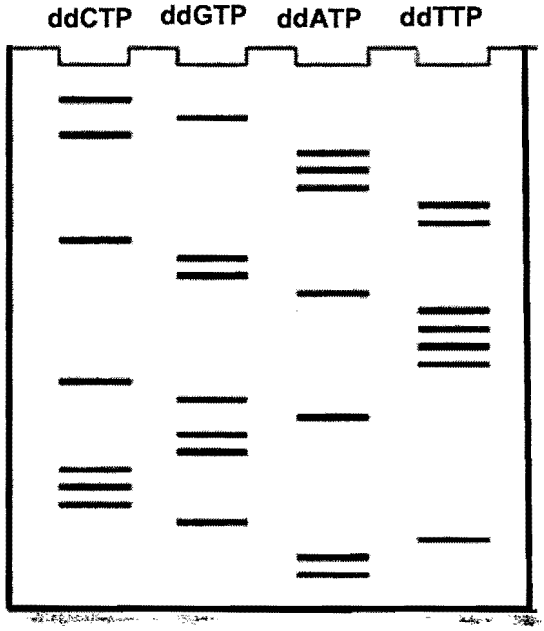
(ii) If the same *tet*^{R} gene (cloned in a completely nonhomologous vector) is made radioactive and used as a probe in a Southern blot of this gel, which bands do you expect to appear radioactive on an autoradiogram? Explain your answer. (3 marks)

(iii) If the same gene of interest from a fly closely related to *Drosophila* has been cloned in a nonhomologous vector and is used as a probe for the same gel, which bands do you expect to see on the autoradiogram? Explain your answer. (3 marks)

Question 7 cont.

(b) Explain the principle behind Sanger sequencing and cycle sequencing of nucleic acids. Hence, state the difference between traditional Sanger sequencing and cycle sequencing methods. (5 marks)

(c) A cloned fragment of DNA was sequenced by using the di-deoxy chain termination method. A part of the autoradiogram of the sequencing gel is represented here.



(i). Deduce the nucleotide sequence of the DNA nucleotide chain synthesized from the primer. Label the 5′ and 3′ ends. (5 marks)

(ii). Deduce the nucleotide sequence of the DNA nucleotide chain used as the template strand. Label the 5′ and 3′ ends. (3 marks)

[TOTAL MARKS = 25]

Question 8

(a) Explain DNA microarray technology in relation to gene knock out and gene knockdown, highlighting where these technologies may be applied. (6 marks)

(b) Critique how understanding of interactomics may aid in metabolic engineering studies. (6 marks)

(c) Illustrate how siRNA, shRNA and miRNA are produced in a cell. Hence, explain how these RNAs effect RNA interference in eukaryotic cells. (8 marks)

(d) Distinguish between minisatellites and microsatellites, highlighting why microsatellites are commonly used in modern day forensic investigations. (5 marks)

[TOTAL MARKS = 25]

END OF QUESTION PAPER