UNIVERSITY OF SWAZILAND

FINAL EXAMINATION PAPER: MAY 2012

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 FOR EACH SECTION.
3. ANSWER A TOTAL OF FOUR QUESTIONS, CHOOSING ONE QUESTION FROM EACH SECTION.
4. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS
5. ILLUSTRATE YOUR ANSWER WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE

SPECIAL REQUIREMENTS: NONE

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

SECTION A

Answer one question from this section

Question 1

Write an essay on "the role of water quality controllers in sanitary microbiology" (25 marks)

[Total marks = 25]

Question 2

Demonstrate the use of microorganisms in industrial settings. (25 marks)

[Total marks = 25]

SECTION B

Answer one question from this section

Question 3

Name the two most important resources that can be obtained from fresh-water bodies in the developing countries of the world. Discuss how these resources and hydrophytes are utilized for the socio-economic benefits of the people of Swaziland. (25 marks)

[Total marks = 25]

Question 4

(a) Explain the term eutrophication. (5 marks)

(b) What are organic pollutants? Briefly discuss the effects of these pollutants in lentic systems. (10 marks)

(c) Schistosomiasis may become a major water-borne parasitic disease affecting people in the low-veld of Swaziland. Discuss. (10 marks)

[Total marks = 25]

SECTION C
Answer one question from this section

Question 5

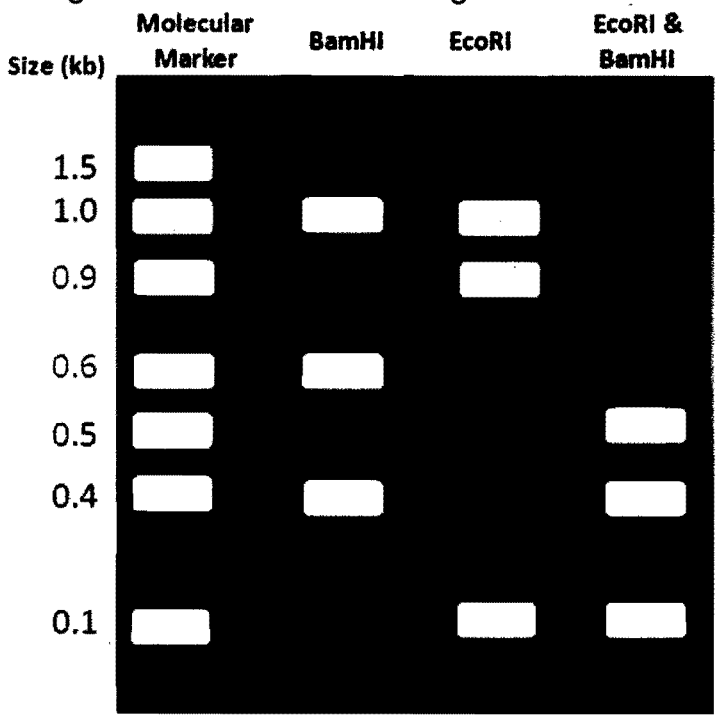
(a) Give any three reasons why a molecular biologist would want to extract plant, microbial or human DNA. (3 marks)

(b) DNA can be extracted from biological samples using Extraction Kits, Phenol-Chloroform method or CTAB-based method. Explain the role of any <u>five</u> of the following in DNA extraction protocols:

(i) Cetyltrimethylammonium bromide (CTAB), (2 marks)
(ii) Polyvinylpyrrolidone (PVP), (2 marks)
(iii) ß-mercaptoethanol, (2 marks)
(iv) Proteinase K, (2 marks)
(v) Tris, (2 marks)
(vi) Phenol, (2 marks)
(vi) Chloroform, (2 marks)
(viii) Isoamyl alcohol, (2 marks)
(ix) Isopropyl alcohol (isopropanol), (2 marks)
(x) Ethanol. (2 marks)

(b) When performing gel electrophoresis of DNA that has been incubated with endonucleases, explain the behaviour or movement of fragments in the gel when current is passed. (2 marks)

(c) A DNA fragment was partially digested with *Bam*HI in one experiment and partially digested with *Eco*RI in the second experiment and in the third experiment, it was completely digested with both restriction enzymes. The following electrophoretogram shows how the resulting fragments appeared after EtBr-stained gel was viewed under UV light.



(i) What is the size of the uncut DNA sample? (1 mark)

(ii) From the electrophoretogram above, elucidate the restriction map of the DNA sample. (7 marks)

(iii) Suppose results of the double digestion of the DNA sample with BamHI and EcoRI yielded 0.6, 0.3 and 0.1kb fragments (as opposed to 0.5, 0.4 and 0.1kb), illustrate how the above electrophoretogram would look like. (*Draw only the banding pattern of the last lane*) (2 marks)

[Total marks = 25]

Question 6

As a bioinformatician, outline how you would tentatively identify an unknown species of bacteria that has just been isolated. (Hint: use relevant molecular biology and bioinformatics techniques/tools). (25 marks)

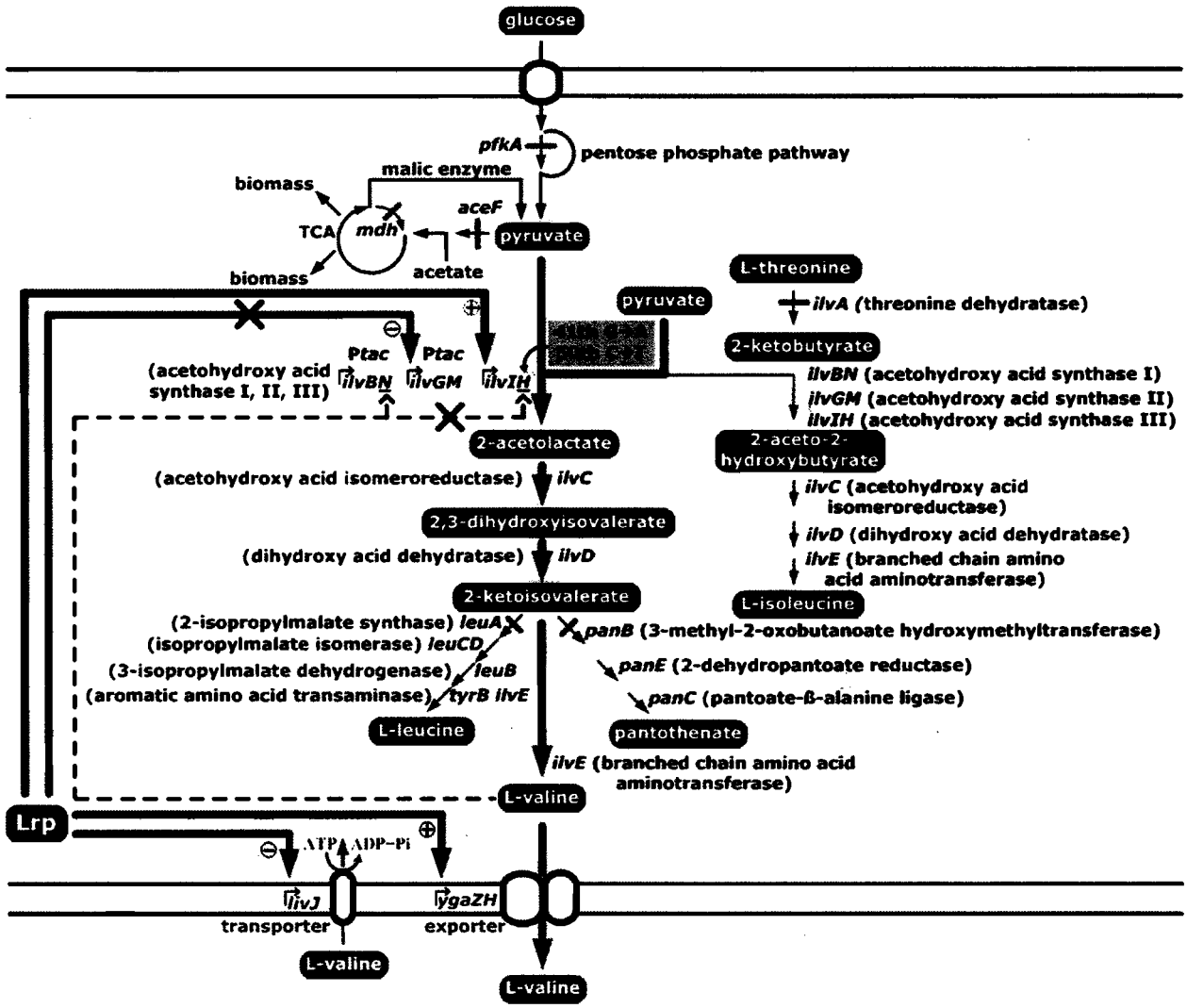
[Total marks = 25]

SECTION D
Answer one question from this section

Question 7

(a) What do you understand by metabolic engineering? (1 mark)

(b) L-valine, an essential hydrophobic and branched-chain amino acid, is used as a component of cosmetics and pharmaceuticals as well as animal feed additives and it can be produced by genetically engineered *Escherichia coli*. Shown below is a biosynthetic pathway for commercial production of L-valine in *E. coli*.



*(Source: Park J H et al. 2007. PNAS **104**:7797-7802)*

Elucidate the regulations involved and genetic strategies used for constructing the L-valine-producing *E. coli* strain. (6 marks)

(c) Explain what short tandem repeats (STRs) are and why STR polymorphisms are widely used by forensic geneticists. (6 marks)

(d) Apart from STRs, list any three (3) other molecular markers that can be used in human forensic investigations. (4 marks)

(e) Evaluate the application of PCR in GMO detection, highlighting the differences amongst event-specific, construct-specific and transgene-specific PCR methods. (8 marks)

[Total marks = 25]

Question 8

(a) Explain the terms functional genomics and comparative genomics. How are they related? (3 marks)

(b) Explain how knock-out mice help determine human gene function. (3 marks)

(c) Discuss the mechanism and role/application of RNA interference (RNAi) in regulation of gene expression, cellular defense and therapeutics. (12 marks)

(d) Critique the concept of gene therapy, highlighting the principle, problems and future prospects. (7 marks)

[Total marks = 25]

END OF QUESTION PAPER