UNIVERSITY OF SWAZILAND

MAIN EXAMINATION: MAY 2016

TITLE OF PAPER: APPLIED BIOLOGY

COURSE CODE: B405

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: 1.   THIS PAPER IS DIVIDED INTO <u>FOUR</u> SECTIONS

2.   ANSWER A TOTAL OF <u>FOUR QUESTIONS</u>, CHOOSING <u>ONE QUESTION</u> FROM <u>EACH SECTION</u> AND USING <u>SEPARATE</u> ANSWER BOOKLETS FOR EACH SECTION.

3.   EACH QUESTION CARRIES TWENTY FIVE (25) MARKS

4.   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

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SECTION A (Answer **one** question from this section).

Question 1

Emerging problems: potential solutions! Does this statement apply to emerging and re-emerging diseases in humans? Discuss. (25 marks)

[TOTAL MARKS = 25]

Question 2

Choose any plant disease of your choice and explain the following on it:

(a) Symptoms, (6 marks)

(b) Biology of the causal agent, (6 marks)

(c) Epidemiology, (6 marks)

(d) Disease control strategies. (7 marks)

[TOTAL MARKS = 25]

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SECTION B (Answer **one** question from this section)

Question 3

Critically analyse the pros and cons of using genetically modified crops with regard to economic and ecologic concerns. (25 marks)

[TOTAL MARKS = 25]

Question 4

(a) Define the following and explain how each arises after chemical control:
Resistance, (5 marks)
Resurgence, (5 marks)
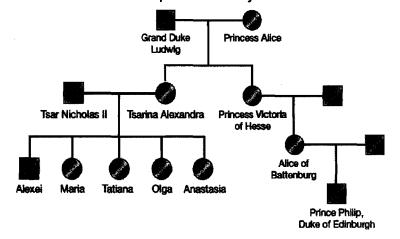Replacement. (5 marks)

(b) "Invertebrates are the little things that run the world." Briefly discuss this statement with regard to three ecosystem services provided by invertebrates.
(10 marks)

[TOTAL MARKS = 25]

SECTION C (Answer one question from this section)

Question 5

The Romanovs and their descendants ruled Russia from the early 17th century until the time of the Russian Revolution, when the Emperor Nicholas Alexandrovich Romanov (Tsar Nicholas II) was overthrown and he and his wife, Empress Alexandra Feodorovna (The Tsarina) and their five young children (4 girls and one boy, Crown Prince Alexei Nikolaevich) were imprisoned. On 17 July 1918, all seven, along with their doctor and three servants, were murdered and their bodies were buried in a shallow roadside grave near Yekaterinburg. In 1991, after the fall of communism, the remains were exhumed so the royals could be given a more befitting burial. Although it was suspected that the bones recovered were indeed those of the Romanovs, the possibility that they belonged to some other unfortunate group of people could not be discounted. Only DNA fingerprinting could solve the puzzle. Nine skeletons, instead of the expected eleven, were found in the grave (2 female adults - FA1 and FA2; 4 male adults - MA1, 2, 3 and 4 and three children Kid1, 2 and 3). Sex-typing of the nine remains was done using a gender-specific microsatellite marker locus and five distinct autosomal STR loci were used to test the hypothesis that the three female children were sisters and that two of the adults were their parents (Tsar and Tsarina). The perplexing question was that if indeed the remains were those of the Romanovs, where were the other two children (one girl and one boy, Alexei)? The Tsarina has a living maternal relative, HRH Prince Philip, Duke of Edinburgh, who is the husband to Queen Elizabeth II of Britain (see the pedigree below). However, in 2007, the remains of the male and female children were found 70 metres away from the Romanovs mass grave and were believed to be those of Alexei and his fourth sister, Anastacia. The grave of the Tsar's brother, George Romanov is known and DNA sample can easily be obtained from it.

Microsatellite analysis of bone DNA from the 9 remains in one mass grave was done using 5 STR loci (L1 to L5) and genotypes are as indicated in the table below. Use the information presented here to answer the questions that follow.

		Kid1	Kid2	Kid3	FA1	FA2	MA1	MA2	MA3	MA4
STRs @ 5 Loci	L1	15,16	15,16	15,16	15,16	16,17	14,20	17,17	15,16	15,17
	L2	8,10	7,8	8,10	8,8	6,6	9,10	6,10	7,10	6,9
	L3	5,7	5,7	3,7	3,5	6,7	6,16	5,7	7,7	5,7
	L4	12,13	12,13	12,13	12,13	11,12	10,11	10,11	12,12	8,10
	L5	11,32	11,36	32,36	32,36	-	-	11,30	11,32	-

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(a) Explain what is meant by DNA fingerprinting.   (2 marks)

(b) In one or two sentences, judge the appropriateness of application of microsatellites (STRs) in solving the mystery above.   (2 marks)

(c) Explain how scientists could forensically distinguish males from females buried in the mass grave.   (2 marks)

(d) Decipher the unequivocal evidence that the three children (Kid1, Kid2 and Kid3) were sisters.   (3 marks)

(e) There were two female adults and four male adults in the mass grave. Point out with, justification, the STR profiles of the Tsar and the Tsarina   (5 marks)

(f) Explain how one could use the STR analysis to investigate whether the remains of the male and female children found 70 meters away from the first mass grave were indeed those of Alexei and Anastacia.   (3 marks)

(g) Using the pedigree above, devise how a named forensic DNA typing would be used to corroborate or refute the deductions in 5(e) and 5(f).   (5 marks)

(h) Explain how George Romanov's DNA can be used to further authenticate the remains of the Tsar and Alexei as construed in 5(e) and 5(f).   (3 marks)
[Total marks = 25]

QUESTION 3
The table below shows results serum enzyme assays done to diagnose an unknown disease. Use the data to decipher the pathological condition of a 21 year old male patient who drinks beer but does not do any sport. Also articulate the prudence behind performing multiple assays.   (25 marks)

Enzyme Assays	Normal Range of serum concentration or activity	Assay Results
Lactate Dehydrogenase, LDH1 (HHHH)	Total LDH 120-280 IU/L For LDH1: 17-27% of	20% of total LDH
Lactate Dehydrogenase, LDH4 (HMMM)	Total LDH 120-280 IU/L For LDH4: 8-16% of total	20%of total LDH
Lactate Dehydrogenase, LDH5 (MMMM)	Total LDH 120-280 IU/L For LDH5:6-16%.	52%of total LDH
Alkaline Phosphatase (ALP)	25 - 125 IU/L Children: 25-350 IU/L); Adult males: 25-125 IU/L	632 IU/L
Alanine Aminotransferase (ALT)	5 - 50 IU/L	55IU/L
Creatine kinase 1 (CK-BB)	<1% of total CK	0% of total CK
Creatine kinase 2 (CK-MB)	<2% of total CK	1% of total CK
Creatine kinase 3 (CK-MM)	98% of total CK Total CK for Adult males: 38-174 IU/L	99% of total CK
Aspartate aminotransferase(AST, SGOT)	5-40 IU/L	70 IU/L
γ-glutamyl transferase	10 - 45 IU/L Males: $\leq$45 IU/L	200 IU/L
Aldolase	Adults: 0-7IU/L	3 IU/L
5'-nucleotidase (5'-NT)	2 - 17 IU/L	120 IU/L

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SECTION D (Answer **one** question from this section)

Question 7

Articulate three arguments that you might use to convince your Member of Parliament that conserving biological diversity is important. (25 marks)

[TOTAL MARKS = 25]

Question 8

Discuss three key factors that are most threatening to biodiversity globally and how these vary among different taxa. (25 marks)

[TOTAL MARKS = 25]

END OF QUESTION PAPER