UNIVERSITY OF SWAZILAND

FINAL EXAMINATION PAPER: MAY 2018

TITLE OF PAPER: APPLIED BIOLOGY
COURSE CODE: B405
TIME ALLOWED: THREE HOURS

INSTRUCTION: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

[PLEASE TURN OVER]

SECTION A (Answer one question from this section).

Question 1

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 and (6 marks)

d) Disease control strategies (7 marks)

[TOTAL MARKS = 25]

Question 2

Discuss the role of industrial microbiology in the socio-economic development of the Kingdom of Swaziland. (25 marks)

[TOTAL MARKS = 25]

QUESTION 1

Briefly explain what is meant by the 'earth's life support systems.' In tabular form as shown below, identify a life support system associated with each of the items indicated. For each, specify how the system is affected (impact/consequence) and how this can be minimised (mitigation). (25 marks)

Activity	Life support system affected (1)	How affected? (2)	Solution/Mitigation (2)
i. Pesticide use			
ii. Monocultures			
iii. *Bt* seed / genetic engineering			
iv. Pollinators killed			
v. Construction of water reservoirs			

[TOTAL MARKS = 25]

QUESTION 2

Discuss in detail the differences between agroecosystems and natural ecosystems. (25 marks)

[TOTAL MARKS = 25]

Section C (Answer One Question from this Section)

Question 5

The table below shows results serum enzymes assays 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 comment on the prudence of behind performing these multiple assays. (25 marks)

Enzyme Assays	Normal Range of serum concentration or activity	Assay Results
Lactate Dehydrogenase, LDH1 (HHHH)	Total LDH 120-280 U/L For LDH1: 17-27% of total	20% of total LDH
Lactate Dehydrogenase, LDH4 (HMMM)	Total LDH 120-280 U/L For LDH4: 8-16% of total	20% of total LDH
Lactate Dehydrogenase, LDH5 (MMMM)	Total LDH 120-280 U/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	55 IU/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: ≤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

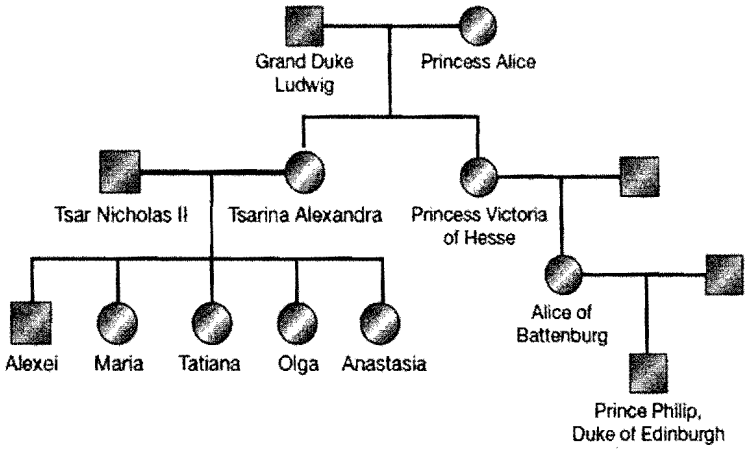
Question 6

Read the passage below and answer questions that follow.

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 grave near Yekaterinburg. In 1991, after the fall of communism, the remains were exhumed so that the royals could be given a more befitting burial. Although it was suspected that the bones recovered were could be those of the Romanovs, the possibility that they belonged to some other unfortunate group of people could not be disputed. Only **DNA fingerprinting** could solve the puzzle. Nine skeletons, instead of the expected eleven, were found in the grave. Sex-typing of the nine remains was done using a gender-specific microsatellite marker locus whereupon 2 female adults - **FA1** and **FA2**; 4 male adults - **MA1**, **MA2**, **MA3** and **MA4** and three children - **C1**, **C2** and **C3** were identified. Also 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, The 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 for kiship testing if need be. Microsatellite analy sis 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.



		C1	C2	C3	FA1	FA2	MA1	MA2	MA3	MA4
STR 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	-

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

(b) Briefly comment on why microsatellites (STRs) are suitable in solving the mystery above. (2 marks)

(c) Explain how the sex of the remains was determined. (see Line 13). (2 marks)

(d) Identify the evidence that the three children (**C1**, **C2** and **C3**) were sisters. (3 marks)

(e) Identify the STR profiles of the **Tsar** and the **Tsarina** from the data given above. (5 marks)

(f) Explain how the STR data could be used to determine whether the remains of the male and female children found 70 meters away from the first mass grave were those of **Alexei** and **Anastacia**. (3 marks)

(g) Using the pedigree above, describe how a named DNA typing could be used to corroborate or refute the deductions in **6(e)** and **6(f)** above. (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 **6(e)** and **6(f)**. (3 marks)

[Total marks = 25]

SECTION D (Answer one question from this section).

Question 7

(a) Discuss the attributes that are considered important in a breeding programme of maize (*Zea mays*). (10 Marks)

(b) Give an illustrative account of the morphology of the maize crop as it relates to plant breeding in this cereal crop. (15 Marks)

[TOTAL MARKS = 25]

Question 8

Discuss the significance of sorghum (*Sorghum bicolor*) as a grain crop in Africa, and especially in the SADC region. (25 Marks)

[TOTAL MARKS = 25]