FACULTY OF SCIENCE

DEPARTMENT OF BOTANY AND PLANT BIOTECHNOLOGY

LSFT0A3/ LS3AFET

LIFE SCIENCE 3A FET

APK CAMPUS

JUNE EXAM

MEMORANDUM

8 JUNE 2017

DATE:	**8 JUNE 2017**
SESSION:	**12:30-15:30**
ASSESSOR:	**MS J. WILLIAMSON**
INTERNAL MODERATOR:	**DR. A. NEL**
EXTERNAL MODERATOR:	**PROF. J. DE BEER**
DURATION:	**3 HOURS**
TOTAL MARKS:	**150**

NUMBER OF PAGES: 18 PAGES

Please read the following instructions carefully

1. Answer all the questions in the question paper
2. Answer ALL of the questions in the test book.
3. Work neatly.
4. Read your questions carefully.
5. Good Luck

QUESTION 1 **[18]**

Choose the alternative that best completes the statement or answers the question. Only write down the correct letter next to the appropriate question number.

1.1 Imagine a genetic counsellor working with a couple who have just had a child who is suffering from Tay-Sachs disease. Neither parent has Tay-Sachs, nor does anyone in their families. Which of the following statements should this counsellor make to this couple?

A. "Because no one in either of your families has Tay-Sachs, you are not likely to have another baby with Tay-Sachs. You can safely have another child."

B. "Because you have had one (1) child with Tay-Sachs, you must each carry the allele. Any child you have has a 50% chance of having the disease."

C. "Because you have had one (1) child with Tay-Sachs, you must each carry the allele. Any child you have has a 25% chance of having the disease."

D. "Because you have had one (1) child with Tay-Sachs, you must both carry the allele. However, since the chance of having an affected child is 25%, you may safely have thee more children without worrying about having another child with Tay-Sachs."

E. "You must both be tested to see who is a carrier of the Tay-Sachs allele."

1.2 Most genes have many more than two (2) alleles. However, which of the following is also true?

A. At least one (1) allele for a gene always produces a dominant phenotype.

B. Most of the alleles will never be found in a live-born organism.

C. All of the alleles but one (1) will produce harmful effects if homozygous.

D. There may still be only two (2) phenotypes for the trait.

E. More than two (2) alleles in a genotype is lethal.

1.3 Cystic fibrosis affects the lungs, the pancreas, the digestive system, and other organs, resulting in symptoms ranging from breathing difficulties to recurrent infections. Which of the following terms best describes this?

A. Incomplete dominance

B. Multiple alleles

C. Pleiotropy

D. Epistasis

1.4 Diploidy is first re-established following _____

A. fertilization.

B. gastrulation.

C. parthenogenesis.

D. organogenesis.

E. ovulation.

1.5 Genetic mutations in asexually reproducing organisms lead to more evolutionary changes than do genetic mutations in sexually reproducing ones because _____

A. asexually reproducing organisms, but not sexually reproducing organisms, pass all mutations to their offspring.

B. asexually reproducing organisms devote more time and energy to the process of reproduction than do sexually reproducing organisms.

C. sexually reproducing organisms can produce more offspring in a given time than can sexually reproducing organisms.

D. more genetic variation is present in organisms that reproduce asexually than is present in those that reproduce sexually.

E. asexually reproducing organisms have more dominant genes than organisms that reproduce sexually.

1.6 Fertilization of an egg without activation is like _____

A. placing the key in the ignition of a car but not starting the engine.

B. resting during halftime of a basketball game.

C. preparing a pie from scratch and baking it in the oven.

D. walking to the cafeteria and eating lunch.

E. dropping a rock off a cliff and watching it land in the valley below.

1.7 The primary function of the corpus luteum is to _____

A. nourish and protect the egg cell.

B. produce prolactin in the alveoli.

C. maintain progesterone and oestrogen synthesis after ovulation has occurred.

D. stimulate the development of the mammary glands.

E. support pregnancy in the second and third trimesters.

1.8 Which hypothalamic hormone triggers the secretion of FSH?

A. Luteinizing hormone (LH)

B. Follicle-stimulating hormone (FSH)

C. Progesterone

D. Human chorionic gonadotropin (HCG)

E. Gonadotropin-releasing hormone (GnRH)

1.9 A woman in the final week of pregnancy who is given an injection of oxytocin would likely_____

A. undergo the loss of oxytocin receptors from her uterine smooth muscle cells.

B. stop secreting prostaglandins from the placenta.

C. undergo vigorous contractions of her uterine muscles.

D. increase the synthesis and secretion of progesterone.

E. be prevented from lactation.

1.10 In his transformation experiments, what did Griffith observe?

A. Mutant mice were resistant to bacterial infections.

B. Mixing a heat-killed pathogenic strain of bacteria with a living non-pathogenic strain can convert some of the living cells into the pathogenic form.

C. Mixing a heat-killed non-pathogenic strain of bacteria with a living pathogenic strain makes the pathogenic strain non-pathogenic.

D. Infecting mice with non-pathogenic strains of bacteria makes them resistant to pathogenic strains.

E. Mice infected with a pathogenic strain of bacteria can spread the infection to other mice.

1.11 A biochemist isolates and purifies various molecules needed for DNA replication. When she adds some DNA, replication occurs, but each DNA molecule consists of a normal strand paired with numerous separate segments of DNA a few hundred nucleotides long. What has she probably left out of the mixture?

A. DNA polymerase

B. DNA ligase

C. Nucleotides

D. Okazaki fragments

E. Primase

1.12 What is meant by the description "antiparallel" regarding the strands that make up DNA?

A. The twisting nature of DNA creates nonparallel strands.

B. The 5' to 3' direction of one strand runs counter to the 5' to 3' direction of the other strand.

C. Base pairings create unequal spacing between the two DNA strands.

D. One (1) strand is positively charged and the other is negatively charged.

E. One (1) strand contains only purines and the other contains only pyrimidines.

1.13 As a ribosome translocates along an mRNA molecule by one codon, which of the following occurs?

A. The tRNA that was in the A site moves into the P site.

B. The tRNA that was in the P site moves into the A site.

C. The tRNA that was in the A site moves to the E site and is released.

D. The tRNA that was in the A site departs from the ribosome via a tunnel.

E. The polypeptide enters the E site.

1.14 A part of an mRNA molecule with the following sequence is being read by a ribosome: 5' CCG-ACG 3' (mRNA). The following charged transfer RNA molecules (with their anticodons shown in the 3' to 5' direction) are available. Two of them can correctly match the mRNA so that a dipeptide can form.

tRNA Anticodon	Amino Acid
GGC	Proline
CGU	Alanine
UGC	Threonine
CCG	Glycine
ACG	Cysteine
CGG	Alanine

The dipeptide that will form will be _____

A. cysteine-alanine.

B. proline-threonine.

C. glycine-cysteine.

D. alanine-alanine.

E. threonine-glycine

1.15 What type s responsible for maintaining the shape of the tRNA molecule?

A. Covale etween sulphur atoms.

B. Ionic b en phosphates.

C. Hydro between base pairs.

D. Van de actions between hydrogen atoms.

E. Peptide tween amino acids.

1.16 A cell divi ce two (2) daughter cells that are genetically different.

A. The sta ie for mitosis only.

B. The st rue for meiosis I only.

C. The sta ie for meiosis II only.

D. The sta ie for mitosis and meiosis I.

E. The sta ue for mitosis and meiosis II.

1.17 If an orga d and a certain gene found in the organism has 18 known alleles (variants) en organism of that species can/must have which of the following?

A. At mos leles for that gene.

B. Up to 1 nes with that gene.

C. Up to 1 that trait.

D. A hapl f 9 chromosomes.

E. Up to, l than, 18 different traits.

1.18 A tetrad ir n of the following sets of DNA strands?

A. Two (2 ided chromosomes that have synapsed.

B. Two (2 ter chromatids that have synapsed.

C. Four (4) sets of sister chromatids.

D. Four (4) sets of unique chromosomes.

E. Eight (8) sets of sister chromatids.

QUESTION 2 **[18]**

Give the correct biological term for each of the following definitions. Only write down the correct term next to the appropriate question number.

2.1 The external appearance of the gene. **Phenotype**

2.2 Different alternatives of a gene. **Allele**

2.3 The relations between successive generations. **Heredity**

2.4 The type of embryonic development found in rabbits. **Altricial**

2.5 The embryonic membrane which disposes of waste products during amniote development. **Allantois**

2.6 The type of cleavage whereby the egg does not divide completely. **Meroblastic cleavage**

2.7 An invasive technique in which amniotic fluid are obtained for genetic analysis. **Amniocentesis**

2.8 The outer layer of the blastocyst. **Trophoblast**

2.9 The cessation of ovulation and menstruation. **Menapause**

2.10 Proteins responsible for the first level of DNA packing in chromatin. **Histones**

2.11 Long strand of DNA which codes for a specific characteristic. **Gene**

2.12 The specific type of sugar found in DNA. **Deoxyribose**

2.13 The starting codon of protein synthesis. **AUG**

2.14 The structure that bonds with the stop codon during the termination process of transcription. **Release factor**

2.15 The structure which helps to bond mRNA to protein of the ribosome. **rRNA**

2.16 Sex chromosomes. **Gonosomes**

2.17 The failure of chromosomes or chromatids to separate normally during meiosis. **Non disjunction**

2.18 Phenomenon where more than two (2) chromosome sets are found in each somatic cell. **Polyploidy**

QUESTION 3 **[19]**

3.1 Wolves are sometimes observed to have black coats and blue eyes. Assume that these traits are controlled by single locus genes and are located on different chromosomes. Assume further that normal coat colour (N) is dominant to black (n) and brown eyes (B) are dominant to blue (b). Suppose the alpha male and alpha female of a pack (these are the dominant individuals who do most of the breeding) are black with blue eyes and normal coloured with brown eyes, respectively. The female is also heterozygous for both traits. How many of the offspring (assume 16) living in the pack will have each of the following genotypes? (Show ALL the detail of the cross) (17)

3.1.1 NNBB – **0** (½)

3.1.2 NNBb - **0** (½)

3.1.3 NNbb - **0**(½)

3.1.4 NnBB - **0**(½)

3.1.5 NnBb - **4**(½)

3.1.6 Nnbb - **4**(½)

3.1.7 nnBB - **0**(½)

3.1.8 nnBb - **4**(½)

3.1.9 nnbb - **4**(½)

P1(½) **nnbb (½)** **x** **NnBb(½)**

Meiosis(½)

Gametes(½) **nb nb nb nb(½)** **NB(½) Nb(½) nB(½) nb(½)**

Fertilization(½)

	nb	nb	nb	nb
NB	NnBb	NnBb	NnBb	NnBb
Nb	Nnbb	Nnbb	Nnbb	Nnbb
nB	nnBb	nnBb	nnBb	nnBb
nb	nnbb	nnbb	nnbb	nnbb
	(½)	(½)	(½)	(½)

Genotype: (½) **4 x NnBb(½)**

4 x Nnbb(½)

4 x nnBb(½)

4 x nnbb(½)

Phenotype: (½) **4 x Normal coat with Brown eyes(½)**

4 x Normal coat with Blue eyes(½)

4 x Black coat with Brown eyes(½)

4 x Back coat with blue eyes(½)

3.2 Briefly name and describe the two (2) laws Mendel formulated after completing a few crosses using pea plants. (4 x ½ = 2)

- **Law of segregation, states that the two alleles for a heritable character separate (segregate) during gamete formation and end up in different gametes**

- **The law of independent assortment states that each pair of alleles segregates independently from another pair of alleles during gamete formation.**

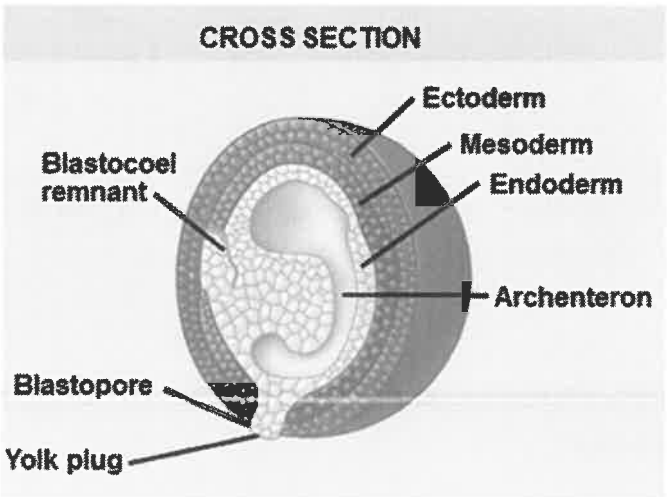
QUESTION 4 **[19]**

4.1 What are the potential advantages of genetic recombination? (3)

- **An increase in variation in offspring.**
- **An increase in the reproductive success of parents in changing environments.**
- **An increase in the rate of adaptation.**
- **Elimination of harmful genes from a population.**

4.2 Embryonic development of a frog after fertilization involves three (3) processes. Name these processes and draw a cross section of the structure which forms at the end of the second process. (11)

1. **Cleavage**
2. **Gastrulation**
3. **Organogenesis**



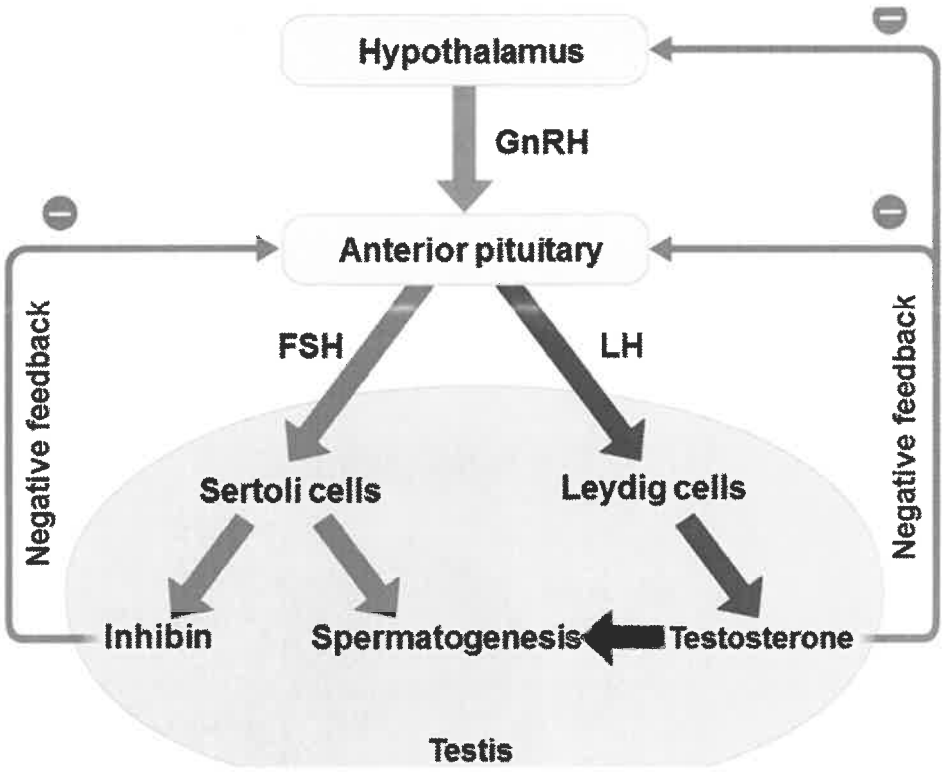
Cross section through the gastrula of a frog.

4.3 Name and discuss the process which sets up a fast block to polyspermy. (5)

- Acrosomal reaction
- Is Triggered when the sperm meets the egg.
- The acrosome, at the tip of the sperm releases hydrolytic enzymes
- that digest material surrounding the egg.
- Gamete contact depolarizes the egg cell membrane and sets up a fast block to polyspermy.

QUESTION 5 **[19]**

5.1 Draw a flow diagram to explain the unique hormonal control of the testes. (11)



5.2 What are the differences between the production of male gametes and the production of female gametes? (5)

- Production of male gametes / sperm – spermatogenesis
- Production of female gametes/ eggs - oogenesis

- In oogenesis, one egg forms from each cycle of meiosis; in spermatogenesis four sperm form from each cycle of meiosis.

- **Oogenesis stops later in life in females; spermatogenesis continues throughout the adult life of males**
- **Oogenesis has long interruptions; spermatogenesis produces sperm from precursor cells in a continuous sequence**

5.3 Describe the structure of the testes. (2 x ½ = 1)

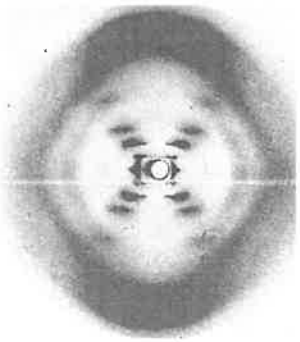
- **Testes, consist of:**
  - **highly coiled seminiferous tubules (in which sperm form) surrounded by connective tissue**
  - **Leydig cells produce hormones and are scattered between the tubules.**

5.4 Explain how temperature change effect the production of sperm and functioning of the testes? (4 x ½ = 2)

- **Production of normal sperm cannot occur at the body temperature.**
- **The testes are held outside the abdominal cavity in the scrotum, where the temperature is 2°C lower than in the abdominal cavity.**
- **Lower temperature – testes closer to body to reduce heat loss**
- **Higher temperature – testes further away from body to increase heat loss.**

QUESTION 6 **[19]**

6.1 Study the image below and answer the questions that follow.



6.1.1 Identify the image above. (1)

X-ray crystallography of a DNA double helix

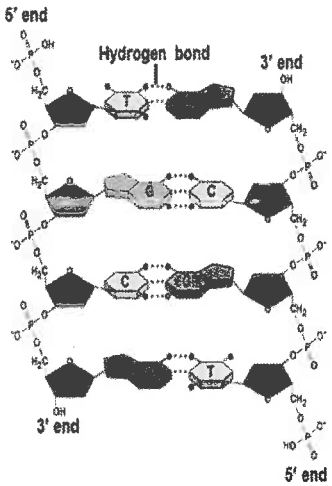
6.1.2 Who first produced this image? (1)

Rosalind Franklin

6.1.3 What features did Watson and Crick deduce from this image to develop a model of this structure in the image? (3)

- **That DNA was helical**
- **The width of the helix**
- **The spacing of the nitrogenous bases**

6.1.4 Draw and label an uncoiled version of the structure in the image. Make sure you draw the shapes accurately and include all necessary bonds. (10 x ½ = 5)



6.2 Study the photo of a specific molecular machine below and answer the questions that follow

6.2.1 What is the machine in the photo above called? (No abbreviations) (1)

Polymerase chain reaction machine

6.2.2 What is this machine used for? (1)

Amplify/ Increase the amount of DNA

6.2.3 Briefly explain how this machine works. (4)

- **Sample containing DNA is heated in a test tube to separate DNA into single strands.**
- **Free nucleotides are added to the test tube with DNA polymerase (enzyme), to allow DNA replication.**
- **DNA is cooled to allow free nucleotides to form a complementary strand along side each single strand.**
- **In this way the DNA is doubled giving sufficient amount of DNA to work with.**

6.3 Discuss of each of the following terms to clarify what it is and what it is used for.

6.3.1 DNA polymerase III (1)

Adds free DNA nucleotides to the RNA primer 3' carbon during DNA replication

6.3.2 Nuclease (1)

Cuts out & replaces damaged stretches of DNA.

6.3.3 Pseudogenes (1)

Former genes that have accumulated mutations and are non-functional

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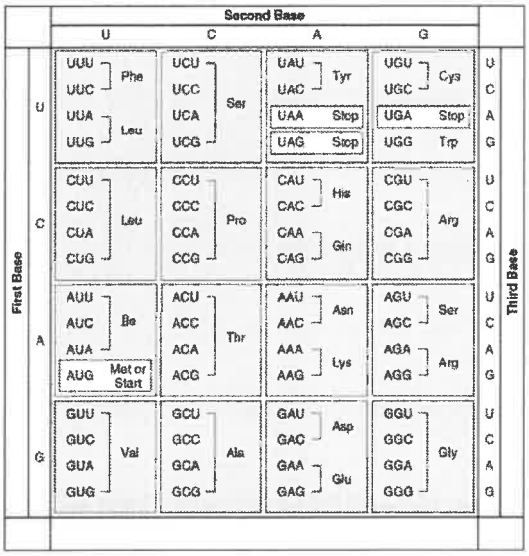
QUESTION 7 **[19]**

7.1 Use the table below to answer the following questions (**Remember in each case to read through the strand and ONLY start at the start codon and STOP when it tells you to stop**)



7.1.1 Determine the amino acid sequence of the following: (6)

Coding DNA strand: CCT CTT ATG CCT TTT AAC CCG TAG CGT AAA

Amino acid sequence: - - MET PRO PHE ASN PRO STOP - -

7.1.2 Determine the tRNA sequence of the following: (4 X ½ = 2)

Template strand: CCC TAC CCA ATA ACT AAA

tRNA: - UAC CCA AUA ACU –

7.2 Protein synthesis consist of two (2) processes. Name these two (2) processes. Where in the cell does each one (1) occur? Each process is subdivided into three (3) phases. Briefly discuss the first phase of the first process. (10)

- **Transcription – in nucleus**
- **Translation – At ribosome in cytoplasm**
- **First phase of Transcription – Initiation**
  - **RNA-polymerase attaches to the beginning of the DNA code**
  - **called the promotor**
  - **Helicase unwinds the DNA molecule and breaks the weak hydrogen bonds between the complementary strands –**
  - **a "bubble forms"**

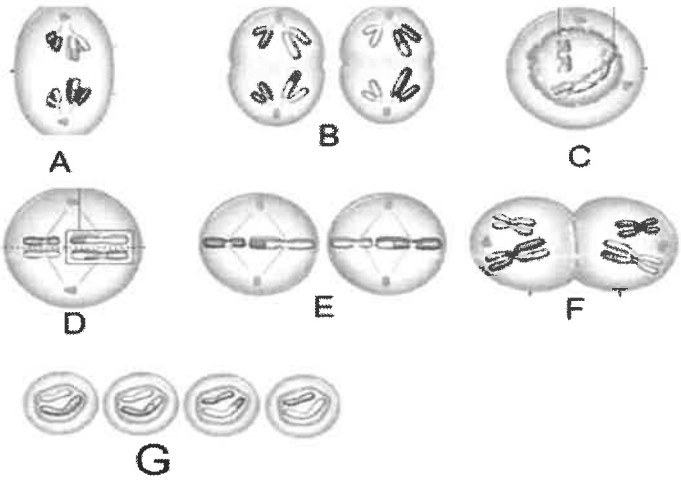
- **The one strand now acts as a template for the formation of the mRNA strand.**

7.3 What is meant by RNA modification? (2 x ½ = 1)

- **Each end of a pre-mRNA molecule is modified in a particular way:**
- **5' end receives a modified nucleotide 5' cap**
- **3' end gets a poly-A tail**

QUESTION 5 **[19]**

8.1 Study the diagrams below and answer the questions that follow.



8.1.1 Identify the phases of meiosis in each of the diagrams below. (7)

- **A – Anaphase I B – Anaphase II**
- **C – Prophase D – Metaphase I**
- **E – Metaphase II F – Telophase I**
- **G – Telophase II**

8.1.2 During which phase (include name and diagram letter) are genes exchanged? What is this process called and why is it important? (3)

- **C- Prophase I**
- **Crossing over**
- **Increase genetic variation**

8.2 Why is meiosis important? (2)

- **It produces haploid gametes which prevents the chromosome number from doubling in every generation.**
- **Produce gametes for fertilization.**

8.3 Why do sex chromosome abnormalities tend to be less severe than autosome abnormalities? (2)

The small size of the Y chromosome or

X-chromosome inactivation

8.4 Discuss the term karyotype. (5)

- **A karyotype is an ordered display of magnified images of an individual's chromosomes arranged in pairs.**
- **Karyotypes allow for the observation of :**
  - **homologous chromosome pairs,**
  - **chromosome number, and**
  - **chromosome structure.**

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