

Copyright 1997, the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta T5K 0L2. All rights reserved. Additional copies may be purchased from the Learning Resources Distributing Centre.

Special permission is granted to **Alberta educators only** to reproduce, **for educational purposes and on a non-profit basis**, parts of this examination that do **not** contain excerpted material **only after the administration of this examination**.

Excerpted material in this examination **shall not** be reproduced without the written permission of the original publisher (see credits page, where applicable).

January 1997

Biology 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, of equal value, worth 30% of the examination
- 80 total possible marks worth 100% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

Tear-out data pages are included near the back of this booklet.

The blank perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A. biology
- B. physics
- C. chemistry
- D. science

Answer Sheet



Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Round and record your answer to three significant digits in the numerical-response section of the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7\end{aligned}$$

Record 23.7 on the answer sheet →

2	3	.	7
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Nervous and endocrine systems maintain internal equilibrium while humans interact with their external environment. The study of organisms and of disease processes has helped extend our knowledge of these systems.

Use the following information to answer the next question.

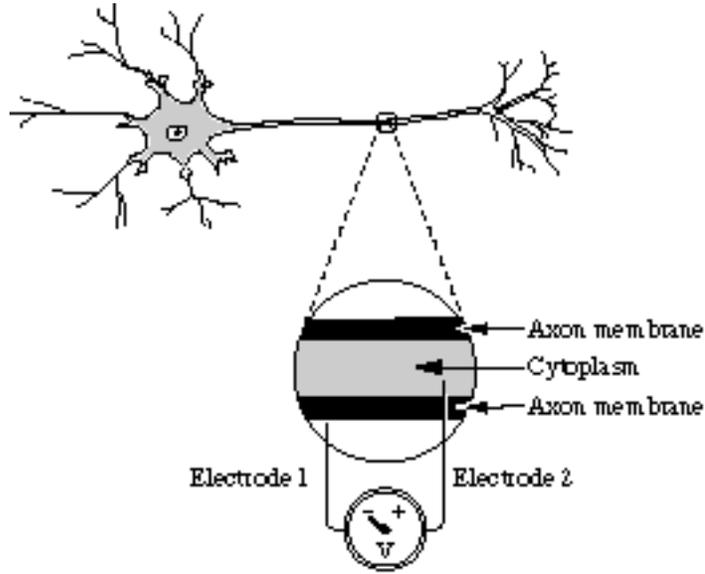
Certain compounds known as opiates (opium, morphine, and codeine) are addictive drugs. Scientists have found that opiates work by binding to specific sites in the brain that interpret perceptions of pleasure and pain.

1. A likely explanation of how receptors in the human brain are stimulated by opiates is that opiates
 - A. bind to neurotransmitters
 - B. act in the same way as cholinesterase
 - C. increase the strength of action potentials
 - D. have molecular shapes similar to a neurotransmitter

Use the following information to answer the next three questions.

Measuring the Membrane Potential of a Spinal Neuron

A microelectrode can be inserted into the axon of a neuron in order to measure the differences in charge between the outside and inside of the cell. A specialized, sensitive voltmeter is used to measure this difference. Electrode 1 is placed on the outside of the cell membrane and Electrode 2 is placed on the inside of the cell membrane.



2. The neuron in an experiment was taken from a spinal cord. The propagation of an action potential in the neuron was slower than the 24 m/s that is typical with sensory neurons. Why?
 - A. Myelination was absent in this spinal neuron.
 - B. Axon length is much longer in sensory neurons.
 - C. The Nodes of Ranvier were absent in sensory neurons.
 - D. The neurotransmitters were blocked in this spinal neuron.

3. The voltmeter showed a negative reading and the sodium ion concentration remained constant outside the axon. How could this be explained?
 - A. The threshold for the neuron was not reached.
 - B. The sodium pump had exhausted ATP reserves.
 - C. The action potential was established and sustained.
 - D. The dendrites were stimulated by the release of acetylcholine.

4. In a resting neuron, the outside of the cell membrane is
- A. positive, and the sodium ion concentration is greater in the fluid outside the axon than in the cytoplasm
 - B. negative, and the sodium ion concentration is greater in the fluid outside the axon than in the cytoplasm
 - C. positive, and the sodium ion concentration is greater in the cytoplasm than in the fluid outside the axon
 - D. negative, and the sodium ion concentration is greater in the cytoplasm than in the fluid outside the axon

Use the following information to answer the next two questions.

A mutation is the cause of fatal familial insomnia and Creutzfeldt/Jakob disease. One symptom of fatal familial insomnia is a drastically reduced heart rate. Individuals with Creutzfeldt/Jakob disease experience personality changes. Both diseases result from lesions or damage in the brain caused by the accumulation of abnormal clumps of prion proteins. Prion proteins are found in the brain tissue of humans. The mutation occurs in a gene coding for a prion protein. One nucleotide in DNA triplet 178 (CTG) is changed, resulting in a new triplet (TTG).

5. Which row correctly identifies the **most likely** location of lesions in each disease?

Row	Location of lesions in fatal familial insomnia	Location of lesions in Creutzfeldt/Jakob disease
A.	cerebellum	hypothalamus
B.	medulla oblongata	hypothalamus
C.	cerebellum	cerebrum
D.	medulla oblongata	cerebrum

6. The **mutated** DNA triplet 178 would be transcribed to the mRNA codon
- A. AAC
 - B. TTG
 - C. UUG
 - D. GAC

Use the following information to answer the next question.

Some Functions of Hormones

- 1 Promote muscle and bone development
- 2 Increase water reabsorption in the kidneys
- 3 Increase the level of amino acids in blood plasma
- 4 Stimulate the conversion of glucose into glycogen

Numerical Response

1. Identify the main function of each hormone named below.

ADH _____ (Record in column 1 on the answer sheet)

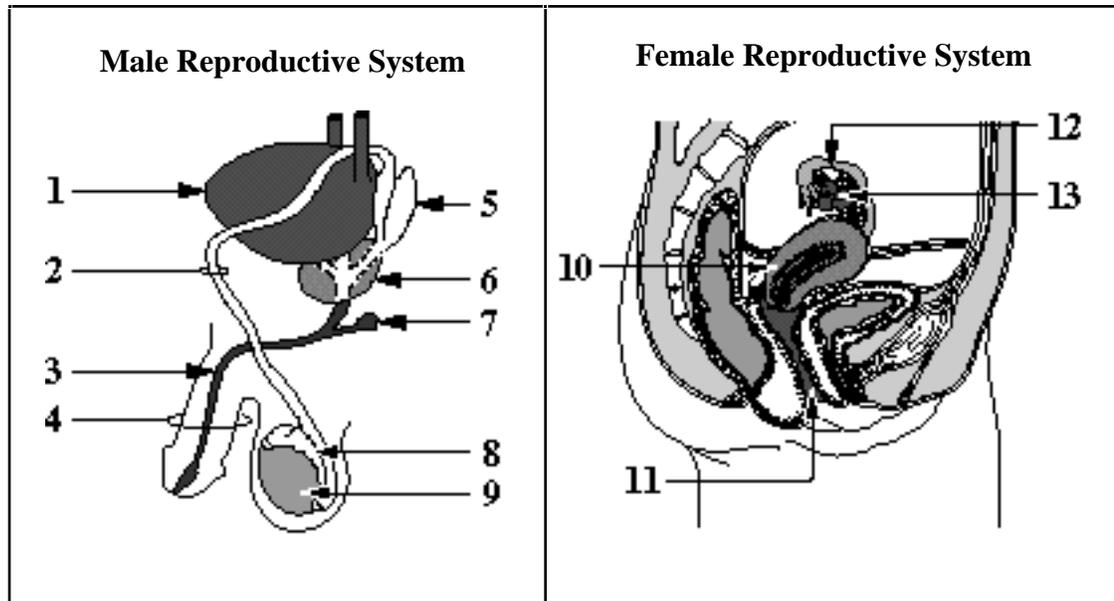
Cortisol _____ (Record in column 2 on the answer sheet)

HGH _____ (Record in column 3 on the answer sheet)

Insulin _____ (Record in column 4 on the answer sheet)

Reproductive processes may be affected by disease, the environment, or the use of technology.

Use the following information to answer the next two questions.



Numerical Response

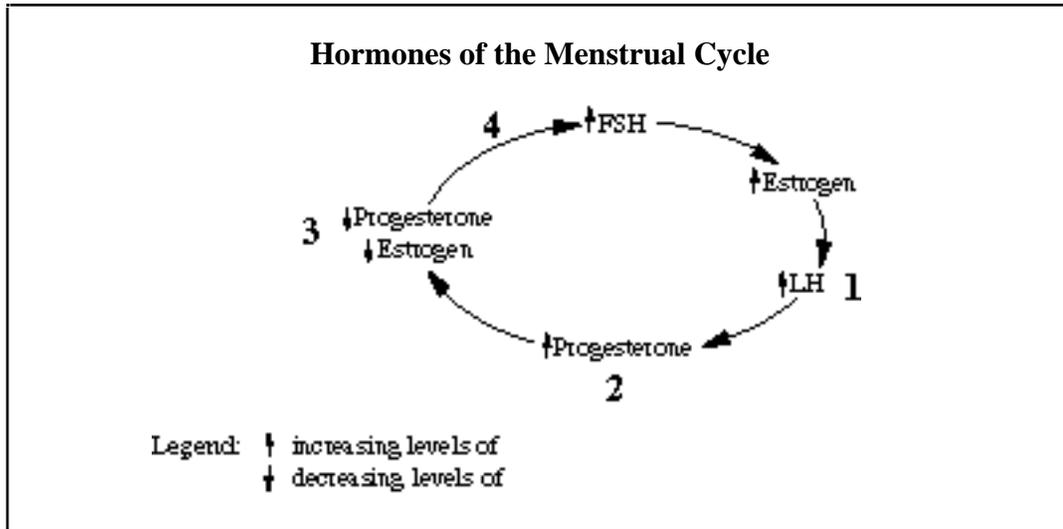
2. What are the structures that are responsible for the **production** of the components of semen?

(Record your **answer in lowest-to-highest numerical order** in the numerical-response section of the answer sheet.)

Answer: _____

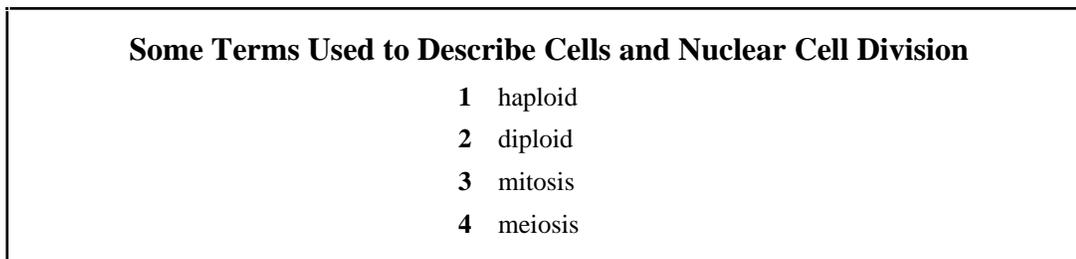
7. The structures that are **directly** affected by hormones secreted from the pituitary gland are structures
- A. 6, 9, and 10
 - B. 9, 10, and 13
 - C. 8, 10, and 11
 - D. 8, 11, and 13

Use the following information to answer the next question.



8. What point on the diagram is **best** matched with the correct event?
- A. Point 1—ovulation
 - B. Point 2—menstruation
 - C. Point 3—formation of the follicle
 - D. Point 4—formation of corpus luteum
-

Use the following information to answer the next question.



Numerical Response

3. Provide the sequence of numbers for the terms that would correctly complete the following statement:

During human fertilization, _____ gametes produced by _____ unite to form a _____ zygote that undergoes _____ to form a fetus.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next question.

Before eggs are harvested for *in vitro* fertilization, hormone supplements are given to the egg donor to ensure that mature ova will be available. Harvested eggs are fertilized and inserted into the recipient's uterus.

9. Which hormone, if given to the egg donor, would promote the growth and development of ova?
- A. LH
 - B. FSH
 - C. Estrogen
 - D. Progesterone
-
10. During the process of implantation, the enzymes secreted by the
- A. ovum digest the zygote membrane
 - B. sperm digest the zygote membrane
 - C. blastocyst digest a portion of the endometrium
 - D. blastocyst digest a portion of the corpus luteum

Use the following information to answer the next question.

At the embryonic level, there is not much difference between being male and being female. At the University of Texas, researcher M. D. Anderson discovered a point in embryonic development when ovaries are present in females and testes are present in males, but in each sex, both sets of ducts (vas deferens and oviducts) coexist. In the female, the lack of testosterone causes the vas deferens to simply wither away. In the male, a second hormone, Müllerian inhibiting hormone (MIH), suppresses the development of female ducts. The MIH gene is located on the X chromosome but has no function identified yet in females.

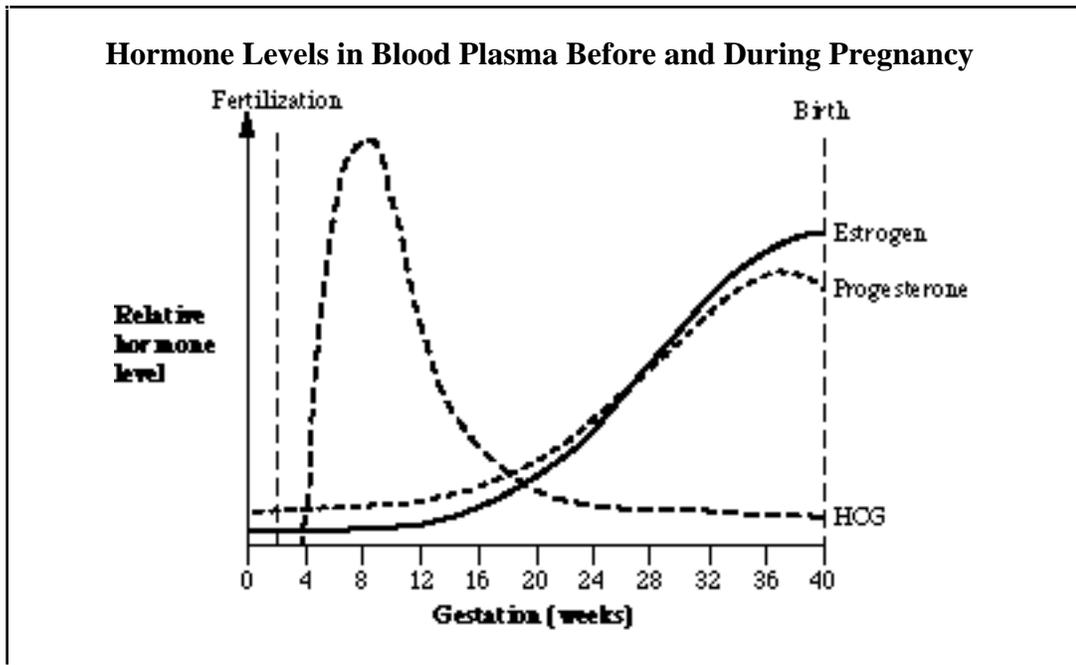
11. If a substance was present in the embryo that inactivated the MIH hormone, male babies would be born with
- A. female reproductive ducts and male sex chromosomes
 - B. male reproductive ducts and female sex chromosomes
 - C. male reproductive ducts and female secondary sexual characteristics
 - D. female reproductive ducts and female secondary sexual characteristics

Use the following information to answer the next question.

One of the major differences between the female and the male sex chromosome genotype is that the male genotype causes the developing genital ridge, which later produces external sex organs, to secrete testosterone, while the female genotype causes this ridge to secrete estrogens. Injection of relatively large quantities of testosterone into pregnant animals produces male sex organs in a fetus, even if the fetus is genotypically female.

12. Which is a logical inference derived from this information?
- A. Male and female embryos would be anatomically similar at one stage of their development.
 - B. The genital ridge would continue to secrete sex hormones during the remaining seven months of pregnancy.
 - C. Injection of large quantities of testosterone into a pregnant female would change the sex chromosomes of the developing embryo.
 - D. Injection of large quantities of estrogen into a pregnant female would enhance the development of existing sex organs in the embryo.

Use the following information to answer the next question.



13. The increasing level of HCG from the time of fertilization until week 8 serves to
- A. maintain the function of the corpus luteum
 - B. determine the sex of the developing embryo
 - C. inhibit the development of the endometrium
 - D. direct the processes of ovulation and fertilization

14. Removal of the mother's ovaries before the seventh week of pregnancy leads to a miscarriage. After 12 weeks, removal of the ovaries usually has no effect on pregnancy. An explanation for these observations is that
- A. after 12 weeks, the endometrium is easily shed
 - B. after 12 weeks, the placenta maintains the pregnancy
 - C. the follicle remains well developed for at least 12 weeks
 - D. implantation is not firmly established until the 12th week

Use the following information to answer the next question.

**Events That Occur During Breast Feeding
(Arranged in Random Order)**

- 1 Release of milk
- 2 Release of oxytocin
- 3 Suckling action of the baby
- 4 Stimulation of sensory neural pathways from the breast to the hypothalamus-pituitary complex

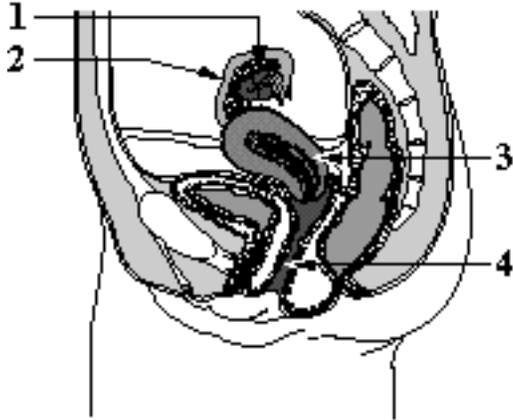
Numerical Response

4. Sequence the events that occur during breast feeding.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____, _____, _____, _____

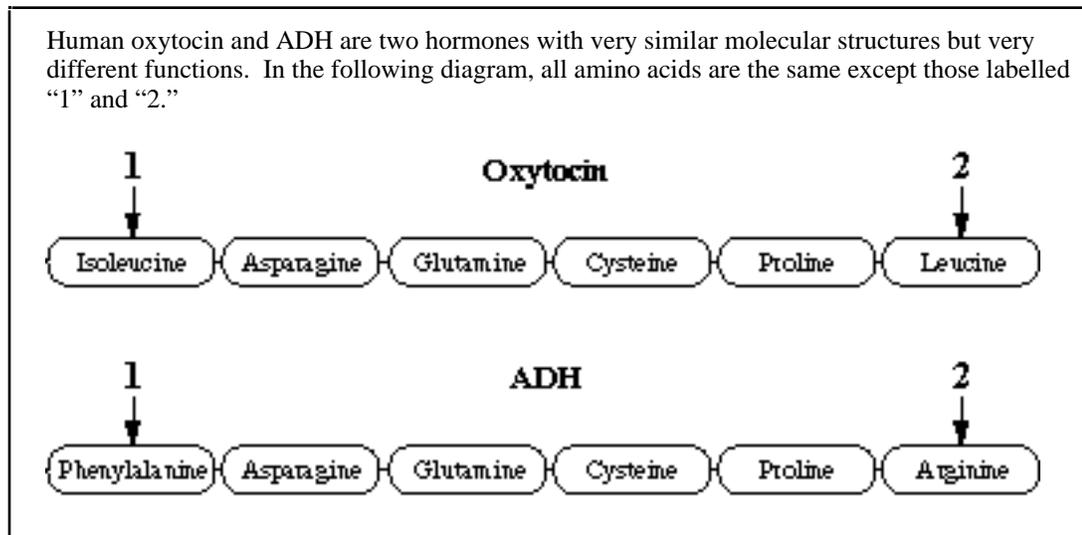
Use the following information to answer the next two questions.

Female Reproductive System	Endometriosis
	<p>In some women, endometrial cells migrate from the uterus to other places in the body, such as surfaces of reproductive organs and organs of the urinary system. This misplaced endometrial tissue responds to hormones in the blood in the same way as the normal endometrium. This causes pain and may severely damage the organ to which the tissue is attached. Women who have endometriosis do not experience these symptoms during pregnancy. Treatment for endometriosis includes removing excess tissue with lasers or using hormone therapy to mimic pregnancy.</p>

15. Which hormones would be used in the hormone therapy treatment of endometriosis?
- A. FSH and LH
 - B. LH and estrogen
 - C. FSH and progesterone
 - D. Progesterone and estrogen
16. The **process of fertilization** would be directly affected by scarring resulting from endometriosis in structure
- A. 1
 - B. 2
 - C. 3
 - D. 4
-
17. At puberty, the LH in the human male **directly**
- A. inhibits the production of sperm
 - B. stimulates the production of testosterone
 - C. causes the growth of facial and body hair
 - D. stimulates the maturation of the seminiferous tubules

The study of cell division, chromosome composition, and the structure and function of DNA increases understanding of growth, genetic continuity, and diversity of organisms.

Use the following information to answer the next two questions.



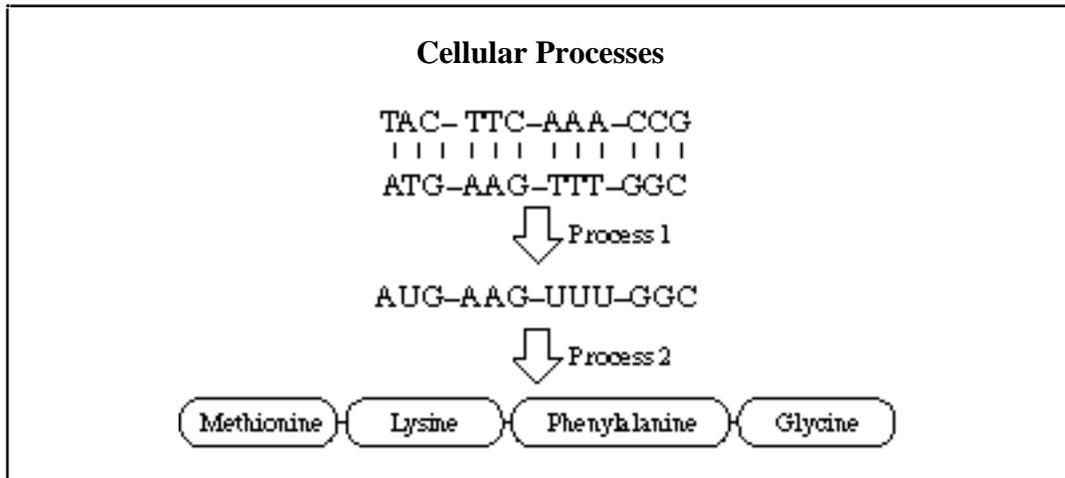
18. The two point-mutations in DNA that would change the code for oxytocin to ADH occur
- A. at 1, where T would be replaced by A
at 2, where A would be replaced by C
 - B. at 1, where A would be replaced by T
at 2, where C would be replaced by A
 - C. at 1, where U would be replaced by A
at 2, where U would be replaced by G
 - D. at 1, where U would be replaced by A
at 2, where G would be replaced by U
19. If a pregnant woman failed to produce oxytocin, what would be the result?
- A. Urination would be more frequent.
 - B. ADH levels in the bloodstream would drop.
 - C. Uterine contractions would not begin for labour.
 - D. Oxytocin levels would increase in the bloodstream.

Use the following information to answer the next question.

Adenine Base Composition of DNA from Some Organisms (%)			
	Organism	Cell Type	Adenine
	Human	Skin	30.4
	Ox	Nerve	29.0
	Salmon	Muscle	29.7
	Sea Urchin	Muscle	32.8

20. Although the adenine base composition of DNA from the above organisms is very similar, these organisms vary greatly in their characteristics. The cause of this variation is that the DNA molecules of the respective organisms contain different
- pairings of nitrogen bases
 - sugars in their nucleotides
 - sequences of nitrogen bases
 - proteins in their nucleotides

Use the following information to answer the next question.

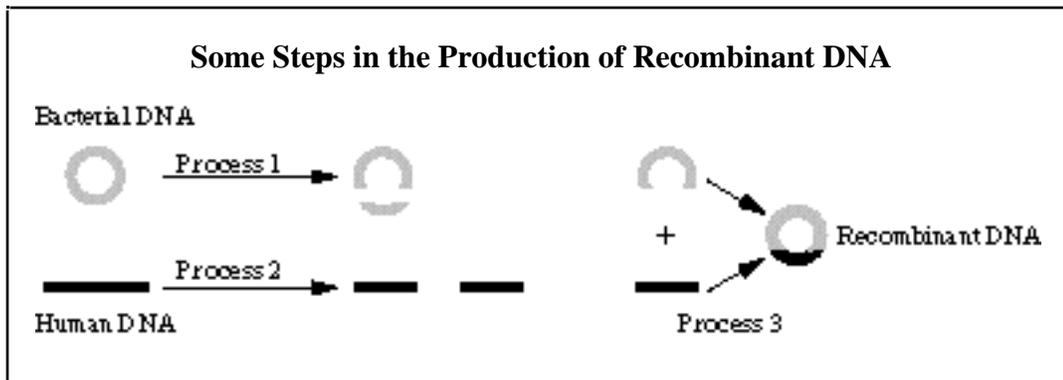


21. Which row correctly identifies processes 1 and 2 and indicates the locations in which these processes occur?

Row	Process 1	Process 2
A.	transcription—nucleus	translation—cytoplasm
B.	translation—cytoplasm	transcription—nucleus
C.	translation—nucleus	transcription—cytoplasm
D.	transcription—cytoplasm	translation—nucleus

22. Using the DNA sequence TCAGGA, the dipeptide formed is
- A. threonine, glycine
 - B. threonine, proline
 - C. serine, proline
 - D. serine, glycine

Use the following information to answer the next question.

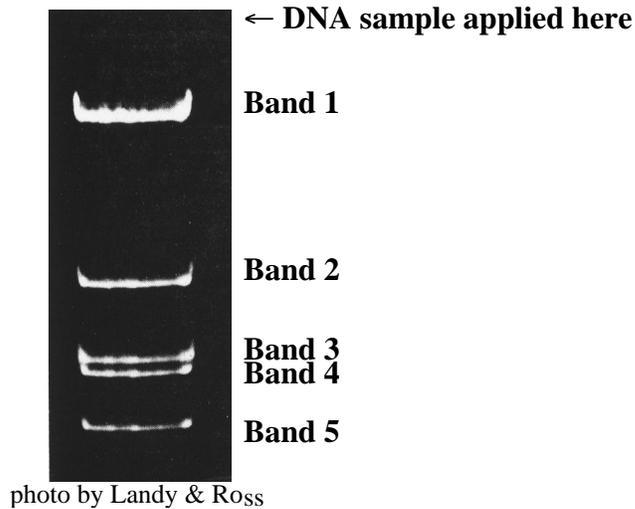


23. Which row correctly identifies the **enzyme-directed** processes 1, 2, and 3?

Row	Process 1	Process 2	Process 3
A.	ligase	restriction enzymes	ligase
B.	restriction enzymes	restriction enzymes	ligase
C.	ligase	ligase	restriction enzymes
D.	restriction enzymes	ligase	restriction enzymes

Use the following information to answer the next question.

Gel electrophoresis is a technique used to separate DNA or protein fragments. A sample of DNA is fragmented by enzymes, and then the sample is placed in a gel. An electric current is passed through the gel. Because the DNA is electrically charged, the DNA fragments migrate. The following gel plate, with distinct bands of DNA, results.



24. Which statement about the DNA fragments on the gel plate is correct?
- A. Band 1 has more base pairs than band 5.
 - B. Band 3 has more base pairs than band 2.
 - C. Band 1 has the least number of base pairs.
 - D. Band 5 has the largest number of base pairs.

Use the following information to answer the next question.

To investigate a sexual assault, a forensic scientist collected a semen sample and analyzed its DNA content in the laboratory. The DNA “fingerprint” that resulted from this analysis was compared with DNA “fingerprints” from three suspects. As a result of the comparisons, two suspects were released and the third suspect was charged.

25. The use of this new technology is valuable for the conviction of criminals because, with the exception of identical twins, every individual is unique with regard to the
- A. type of nucleotides found in DNA
 - B. type of proteins produced by DNA
 - C. protein sequence in some segments of DNA
 - D. nucleotide sequence in some segments of DNA

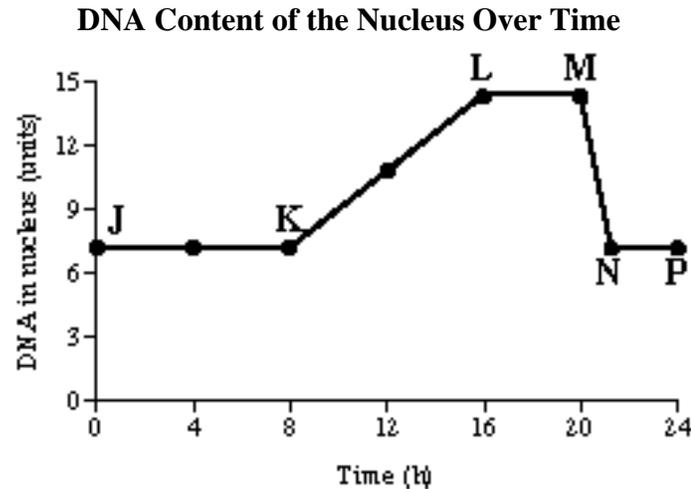
Use the following information to answer the next three questions.

During the **cell cycle**, cells in growing tissue normally progress through **interphase**:

- stage 1—cells grow, carry out normal metabolism, and produce more organelles
- stage 2—DNA replication, chromosome duplication, and cell growth occur
- stage 3—cell growth occurs

and **mitosis**.

Human cells were cultured for a day in a nutrient-rich medium. The DNA content of a typical nucleus was determined every hour, and the data collected were graphed.



26. The process that occurs during interval K–L is
- cytokinesis
 - chromatid separation
 - replication of genetic material
 - synapsis of homologous chromosomes
27. On the graph, N likely indicates the completion of which mitotic event?
- Prophase
 - Anaphase
 - Telophase
 - Metaphase

28. On the graph, interval N–P corresponds to the period between the end of
- A. mitosis and the beginning of stage 1
 - B. stage 2 and the beginning of stage 3
 - C. stage 1 and the end of stage 2
 - D. stage 1 and the end of mitosis
-

29. One difference between mitosis and meiosis is that, during mitosis,
- A. one replication of chromosomes and one division occurs
 - B. one replication of chromosomes and two divisions occur
 - C. two replications of chromosomes and one division occurs
 - D. two replications of chromosomes and two divisions occur

Use the following information to answer the next question.

Chromosome Number of a Horse	
Horse, <i>Equus caballus</i>	66 (2n)

30. Starting from a single cell, spermatogenesis in horses produces
- A. one cell with 33 chromosomes
 - B. two cells, each with 66 chromosomes
 - C. four cells, each with 33 chromosomes
 - D. three cells, each with 22 chromosomes

- 31.** A human with Klinefelter Syndrome has 47 chromosomes and has the XXY chromosome set instead of XY. From what does this abnormality result?
- A.** The process of mitosis does not occur properly.
 - B.** An error in replication produces an extra X chromosome.
 - C.** Crossing over results in the formation of an extra chromosome.
 - D.** Nondisjunction occurs in either the formation of the sperm or the egg.

Use the following information to answer the next question.

In May 1934, Elzire Dionne gave birth to five identical daughters two months prematurely. No one expected the tiny infants to live. But Annette, Emilie, Yvonne, Marie, and Cecile became the first quintuplets ever to survive.

- 32.** The fact that the Dionne Quintuplets were identical indicates that they developed from
- A.** one ovum that was fertilized by five different sperm cells
 - B.** five separate eggs that were released from an ovary simultaneously and then fertilized
 - C.** one zygote that split into five separate surviving embryos during initial mitotic divisions
 - D.** one ovum that underwent mitosis to produce five eggs, each of which was fertilized by one sperm cell

Use the following information to answer the next question.

When conducting his research into the genetics of pea plants, Gregor Mendel crossed true-breeding, yellow-seeded plants with true-breeding, green-seeded plants. He observed that all of the F₁ generation had yellow seeds.

- 33.** In the F₁ generation, the allele for yellow seeds would have been found in
- A.** about 50% of the female gametes and 50% of the male gametes produced by F₁ plants
 - B.** all of the female gametes and none of the male gametes produced by F₁ plants
 - C.** all of the male gametes and none of the female gametes produced by F₁ plants
 - D.** none of the male gametes or female gametes produced by F₁ plants

Use the following information to answer the next three questions.

Some Traits in Garden Pea Plants

In pea plants, the genes for seed shape, seed colour, and plant height demonstrate independent assortment. The alleles for these genes are symbolized as follows:

Seed shape — R (round) > r (wrinkled)

Seed colour — Y (yellow) > y (green)

Plant height — T (tall) > t (short)

34. The phenotypic ratio of a cross between YyTt pea plant and a yyTt pea plant is
- A. 3 yellow tall : 3 yellow short : 1 green tall : 1 green short
 - B. 1 yellow tall : 1 yellow short : 1 green tall : 1 green short
 - C. 3 yellow tall : 1 yellow short : 3 green tall : 1 green short
 - D. 1 yellow tall : 1 yellow short : 3 green tall : 3 green short
35. In a cross between an RrYy plant and an RRYy plant, what fraction of the offspring would be expected to have the genotype RRYy?
- A. 1/2
 - B. 1/4
 - C. 3/8
 - D. 1/8

Numerical Response

5. What percentage of the gametes produced by a pea plant heterozygous for both seed shape and seed colour would be expected to contain both the allele for wrinkled and the allele for green?

(Record your answer as a whole number in the numerical-response section of the answer sheet.)

Answer: _____%

Use the following information to answer the next two questions.

A sweet pea plant variant was found that has purple flowers. When this plant was self-pollinated, the following F₁ offspring were produced.

Phenotype	Number of Offspring
Pink flowers	30
Purple flowers	62
Burgundy flowers	33

36. Which pattern of inheritance for flower colour is demonstrated by this sweet pea plant variant?
- A. X-linked recessive
 - B. Autosomal recessive
 - C. Autosomal dominant
 - D. Incomplete dominance
37. Analysis of a DNA sample from the nuclei of the purple flowers determined that the thymine content of the nucleotides in the DNA was 23%. What is the likely content of adenine, cytosine, and guanine in the DNA?

Row	Adenine	Cytosine	Guanine
A.	23%	27%	27%
B.	23%	27%	23%
C.	27%	23%	23%
D.	27%	23%	27%

Use the following information to answer the next question.

Huntington's disease is a disorder in which two regions of the brain that help control body movement are destroyed; therefore, the diseased body is in perpetual motion. Huntington's disease is thought to have originated as a single **dominant** gene mutation on **chromosome 4** in a small population in northwestern Europe. The disease is spread through inheritance since new mutations are very rare. One in every 10 000 people has the gene.

Numerical Response

- 6.** A man who is heterozygous for the disease allele marries a woman who is homozygous for the normal recessive allele. What is the probability that their first child is a boy and has Huntington's disease?

(Record your **answer as a value from 0 to 1, rounded to two decimal places**, in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next two questions.

Four babies were born in a hospital on the same day. Due to a mix-up at the hospital, there was some confusion as to the identity of the babies.

	Mother	Father
Parents 1	Type A	Type O
Parents 2	Type AB	Type B
Parents 3	Type O	Type B
Parents 4	Type AB	Type O

	Blood Type
Baby W	Type A
Baby X	Type B
Baby Y	Type AB
Baby Z	Type O

38. Of the following, the parent and child combination that could be possible is
- A. parents 1 and baby Y
 - B. parents 2 and baby Z
 - C. parents 3 and baby W
 - D. parents 4 and baby X

Numerical Response

7. The probability that a mother with blood type O and a father with the genotype $I^B i$ would have a child with blood type O is _____.

(Record your answer as a value from 0 to 1, rounded to two decimal places, in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next two questions.

Green–blue–brown eye colour

The biochemistry of eye colour is not completely understood. Part of an explanation for eye colour may be the interaction of the products of three different alleles. The green allele is dominant to blue. The brown allele is also dominant to blue. The green is expressed only in the absence of a brown allele.

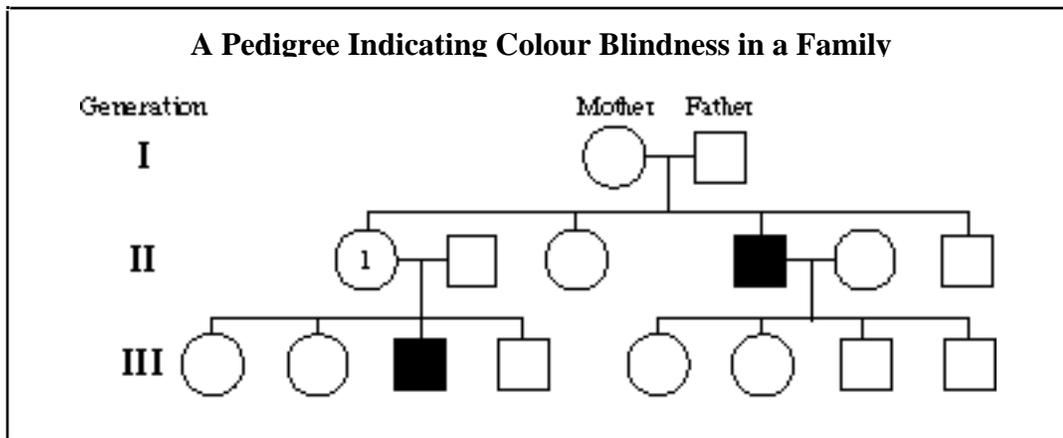
Red–green colour blindness

Red–green colour blindness results from a mutation of an X-linked gene. A mutation in the gene causes red–green colour blindness (X^{cb}), the inability to distinguish between red and green. The X^{cb} allele is recessive.

Legend: B—brown eye colour allele
 b—blue eye colour allele
 G—green eye colour allele
 X^{cb} —colour-blindness allele
 X—normal vision allele

39. A colour-blind male with brown eyes and his green-eyed wife who has normal colour vision have a daughter who is colour-blind and has blue eyes. What is the genotype of this child?
- A. $X^{cb}X^{cb}Bb$
 B. $X^{cb}X^{cb}Gb$
 C. $X^{cb}X^{cb}bb$
 D. $X^{cb}Ybb$

Use the following additional information to answer the next question.



40. If individual 1 has blue eyes, genotypes of her parents could be
- A. mother $XXbb$, father $X^{cb}YGB$
 B. mother $XX^{cb}Gb$, father $XYBb$
 C. mother $XX^{cb}GG$, father $XYbb$
 D. mother $XX^{cb}Gb$, father $X^{cb}YBB$

Numerical Response

- 8.** Three genes have been identified on chromosome two in *Drosophila* (fruit flies). They control eye colour, body hair (bristles), and wing shape. The genes are:

- 1 cinnabar eyes
- 2 short bristles
- 3 curved wings

The crossover frequency between 1 and 3 is 18%, between 2 and 3 is 24.5 %, and between 1 and 2 is 6.5%. Construct a gene map of three genes and indicate their order by number.

(Record your **three-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next question.

In *Drosophila* (fruit flies), straight wing (S) is dominant to curved wing (s). A curved-wing female lays 200 eggs. The eggs hatch into larvae and they mature into adults, all with straight wings.

- 41.** This information indicates that the genotype for the unknown male is likely
- A. homozygous
 - B. heterozygous
 - C. either homozygous recessive or heterozygous
 - D. either homozygous dominant or heterozygous

Communities are made of populations and may reach equilibrium or change over time.

Use the following information to answer the next question.

In *Drosophila* (fruit flies), a gene called Sd (segregation distorter) has been discovered. In heterozygous (Sd/sd) individuals, the Sd allele results in the destruction of gametes containing the sd allele. Those gametes containing the Sd allele develop normally.

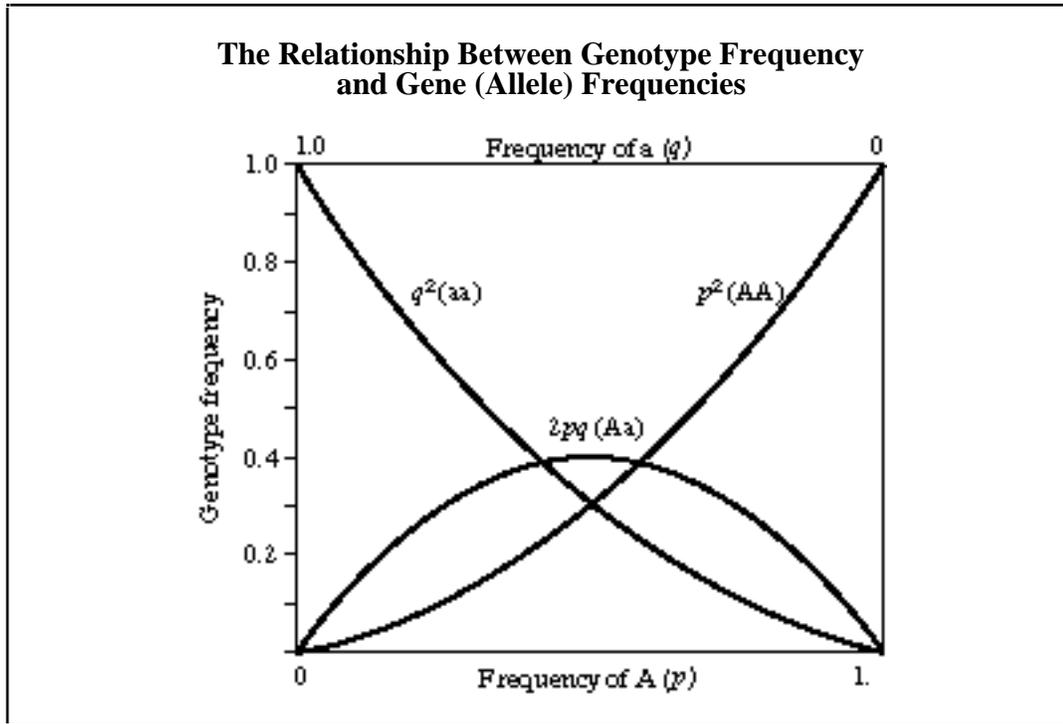
42. The gene pool of *Drosophila* is affected by the Sd allele because this allele
- A. produces new gene combinations
 - B. increases genetic diversity
 - C. favours natural selection
 - D. increases in frequency
-

Use the following information to answer the next question.

In a randomly mating population of *Drosophila*, 4% of the flies have black bodies (an autosomal, recessive trait) and 96% have brown bodies. This population is assumed to be in Hardy–Weinberg equilibrium.

43. If a researcher samples 10 000 *Drosophila* from this population, the number of flies expected to be homozygous dominant for body colour is
- A. 400
 - B. 3 200
 - C. 6 400
 - D. 9 600

Use the following information to answer the next question.



44. These relationships are **not** applicable when there is
- A. a large population size
 - B. absence of migration from a population
 - C. random mating between members of a population
 - D. selection against a particular genotype in a population

Use the following information to answer the next two questions.

Sickle cell anemia is caused by an allele (Hb^S) that codes for abnormal hemoglobin-S. Heterozygous individuals produce both normal hemoglobin and a small percentage of hemoglobin-S. These individuals are more resistant to malaria than individuals who are homozygous for the allele for normal hemoglobin (Hb^A). In areas where malaria is common, the frequency of the allele for hemoglobin-S is higher than in areas where malaria is uncommon.

Malaria is a sometimes fatal disease caused by the micro-organism *Plasmodium falciparum*, which is injected by certain mosquitoes into the bloodstream of humans. In Africa, the frequency of the Hb^S allele relates directly to the presence of malaria-causing organisms. In western Africa, the frequency of the Hb^S allele is 0.15; in central Africa, the frequency is 0.10; and in southern Africa, the frequency is 0.05.

45. If a change in the environmental conditions in western Africa caused an increase in the mosquito population, what would likely happen to the frequencies of the alleles Hb^A and Hb^S ?
- A. The frequency of both alleles would increase.
 - B. The frequency of both alleles would decrease.
 - C. The frequency of the Hb^A allele would increase and the frequency of the Hb^S allele would decrease.
 - D. The frequency of the Hb^A allele would decrease and the frequency of the Hb^S allele would increase.
46. The relationship between humans and *Plasmodium falciparum* is called
- A. parasitism
 - B. mutualism
 - C. competition
 - D. commensalism

Use the following information to answer the next question.

C.F.M. Synnerton, a naturalist in Zimbabwe, studied how eyespots on the wings of butterflies protected the butterflies from predation by sparrows. By moving its wings, the butterfly makes the eyespots resemble the eyes of an owl, a natural predator of sparrows.

47. The presence of eyespots on the wings of butterflies is an example of
- A. mimicry
 - B. mutualism
 - C. camouflage
 - D. competition
-

Use the following information to answer the next question.

Some grey whales have barnacles living on their backs. As the whales move from one location to another, the barnacles are exposed to new sources of their food, plankton. Whales are unaffected by the presence of the barnacles.

48. The relationship between the barnacles and the whales is one of
- A. predation
 - B. parasitism
 - C. mutualism
 - D. commensalism
-

Use the following information to answer the next questions.

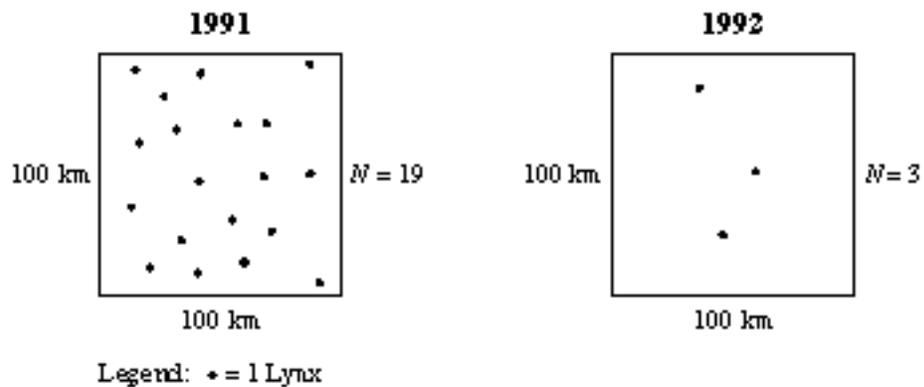
The Lynx–Snowshoe Hare Relationship



Tony Stone Images/Vancouver

The ten-year cycles of the populations of the snowshoe hare and Canada lynx was first recorded from fur returns of Hudson's Bay Company traders in the late 1800s. The cycles revolve around the lynx's preference for hares over other animals as a food source. This predator–prey relationship is again being studied by the Northwest Territories Department of Renewable Resources, in an area known as the Mackenzie Bison Sanctuary.

Lynx Population in the Mackenzie Bison Sanctuary



Written Response – 15% (12 marks)

1. a. Calculate the density of the lynx population in 1991 and 1992. Show your work.

b. Calculate the per capita growth rate for the lynx population from 1991 to 1992. Show your work.

c. The density of the snowshoe hare in the study area was about $800/\text{km}^2$ in 1990 and about $100/\text{km}^2$ in 1991. Identify one possible cause for the change in the **lynx** population density during the 1991 to 1992 time period.

d. After the decline in the hare population, younger male lynx were found to have migrated as far as 500 km from the study area. Explain how the gene pool of the neighbouring lynx populations would be affected.

- e. Lynx have lustrous, long hair. Currently lynx fur is out of fashion in the clothing industry, and a pelt sells for \$60.00. In 1987, when long-haired fur was in high demand, a single lynx pelt sold for \$1 100.00. When lynx fur is out of fashion, predict the change in environmental resistance on the hare population and the corresponding effect on hare population growth.

- f. The birth rate in the lynx population can be estimated by determining litter sizes. Litter size can be determined by two methods. The first method involves counting the number of placental scars on the uterus of a lynx carcass. A scar is left at each implantation site of a fetus. The second method involves counting the number of degenerated corpora lutea (plural of corpus luteum) in the ovaries of the lynx carcass. Neither of these methods provides a completely accurate value for litter size.

Explain why each method produces an overestimation of actual litter size.

- i. counting placental scars _____

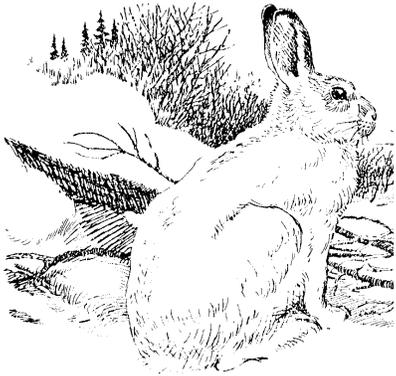
- ii. counting degenerated corpora lutea _____

- g. The procedures described in f. above involve the study of lynx carcasses. Describe one technology that ecologists use to collect data on any **live** animals.

Use this additional information to answer the next question.

Lynx mate in March and have litters of 3 to 5 kittens in May. Lynx kittens are born blind and naked. Their eyes open after 10 days. In 12 weeks, the kittens travel with their mother. They watch and learn how to hunt for hares. Their eyesight is more acute than their hearing or sense of smell. Lynx are active at night (nocturnal).

Hares have litters of 2 to 4 offspring, with up to 4 litters over a summer. Hares are born with their eyes open and bodies fully haired. Birth weight doubles in 8 days. Hares use their good hearing and supersensitivity to ground vibrations, as well as speed and coordination, to escape lynx. Hares are active at night and spend the day grooming and resting.



Hare

Alberta Recreation, Parks and Wildlife



Lynx

Alberta Recreation, Parks and Wildlife

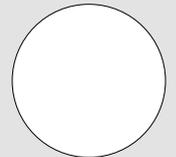
(The lynx is 10x larger than the hare)

- h.** Classify the lynx as an *r*- or *K*-selected species. Provide evidence from the information given to support your choice.

References:

Marty, S. (1995, September/October). The Lynx and the Hare. *Canadian Geographic*.

Poole, K.G. (1992). *Lynx Research in the Northwest Territories, 1991-92*. Manuscript Report No. 68. Government of the NWT.



BIOLOGY DATA

Symbols

Symbol	Description
D_p	population density
N	numbers of individuals in population
A	area, space, or volume occupied by a population
t	time
	change
r	biotic potential OR maximum per capita population growth rate
K	carrying capacity
$\frac{N}{t}$	change in population size during time interval
$>$	greater than, dominant over
$<$	less than, recessive to

Symbol	Description
♂	male
♀	female
n	chromosome number
B, b	alleles; upper case is dominant, lower case is recessive
I^A, I^B, i	alleles, human blood type (ABO)
P	parent generation
F ₁ , F ₂	first, second filial (generation)
p	frequency of dominant allele
q	frequency of recessive allele

Fold and tear along perforation.

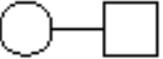
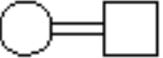
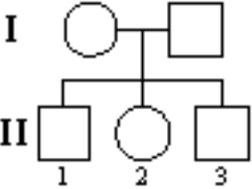
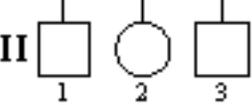
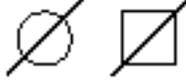
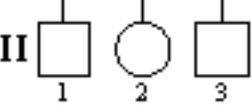
Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	$N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta N}{N}$
Growth rate	$\frac{N}{t} = rN$ $\frac{N}{t} = rN \frac{(K - N)}{K}$

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols

	Male		Identical twins
	Female		Non-identical twins
	Mating		Affected individuals
	Mating between close relatives		Known heterozygotes for autosomal recessive
I 	Roman numerals symbolize generations		Known carrier of X-linked recessive
II 	Arabic numerals symbolize individuals within a given generation		Deceased individuals
	Birth order, within each group of offspring, is drawn left to right, oldest to youngest		Sex unknown

Messenger RNA Codons and Their Corresponding Amino Acids

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon but also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

Fold and tear along perforation.

**Biology 30
Diploma Examination
January 1997**

**Scoring Guide to
Multiple Choice,
Numerical Response, and
Written–Response Questions**



**Biology 30 January 1997 Diploma Examination
Multiple Choice and Numerical Response Keys**

Multiple Choice

- | | |
|-------|-------|
| 1. D | 25. D |
| 2. A | 26. C |
| 3. A | 27. C |
| 4. A | 28. A |
| 5. D | 29. A |
| 6. A | 30. C |
| 7. B | 31. D |
| 8. A | 32. C |
| 9. B | 33. A |
| 10. C | 34. C |
| 11. A | 35. B |
| 12. A | 36. D |
| 13. A | 37. A |
| 14. B | 38. D |
| 15. D | 39. C |
| 16. B | 40. B |
| 17. B | 41. A |
| 18. A | 42. D |
| 19. C | 43. C |
| 20. C | 44. D |
| 21. A | 45. D |
| 22. C | 46. A |
| 23. B | 47. A |
| 24. A | 48. D |

Numerical Response

- | | |
|-----------|------------|
| 1. | 2314 |
| 2. | 5679 |
| 3. | 1423 |
| 4. | 3421, 2134 |
| 5. | 25 |
| 6. | 0.25 |
| 7. | 0.50 |
| 8. | 213, 312 |

Scoring Guide for Question 1

Written Response – 15% (12 marks)

- 1.** a. Calculate the density of the lynx population in 1991 and 1992. Show your work.

Consider both calculations as a unit.

answer or answer or answer or
any equivalent
conversion

$$1991: D_p = \frac{N}{A} = \frac{19\text{lynx}}{(100\text{km})^2} = \frac{19\text{lynx}}{10000\text{km}^2} = 0.0019\text{lynx} / \text{km}^2 \text{ or } 0.0019/\text{km}^2$$

answer or answer or answer or
any equivalent
conversion

$$1992: D_p = \frac{N}{A} = \frac{3\text{lynx}}{(100\text{km})^2} = \frac{3\text{lynx}}{10000\text{km}^2} = 0.0003\text{lynx} / \text{km}^2 \text{ or } 0.0003/\text{km}^2$$

Scoring:

- Check for **both correct answers** (year, correct number, units) **(2 marks)**
 - if answers are correct but units or years are not correctly indicated **(1 mark)**
 - if answers are correct but units and years are not correctly indicated **(0 marks)**
- If answers are incorrect, check work shown
 - if error is in using incorrect area, but units, years, formula, and substitution are correctly indicated **(1 mark)**
 - if error is due to incorrectly solving the density equation but units, years, formula, and substitution are correctly indicated **(1 mark)**
 - if error is due to incorrectly solving equation and using incorrect area **(0 marks)**
- b. Calculate the per capita growth rate for the lynx population from 1991 to 1992. Show your work.

(1 mark) $cgr = \frac{N}{N} = \frac{-16\text{lynx}}{19\text{lynx}} = -0.84 \text{ or "decreases at 0.84"}$

- Accept with or without percent.

- c. The density of the snowshoe hare in the study area was about 800/km² in 1990 and about 100/km² in 1991. Identify one possible cause for the change in the **lynx** population density during the 1991 to 1992 time period.

(1 mark)

any one of:

- increased starvation
- increased emigration
- decrease in numbers of hares
- decreased natality
- increased mortality
- human interference (roads, hunting, etc.)

- d. After the decline in the hare population, younger male lynx were found to have migrated as far as 500 km from the study area. **Explain how** the gene pool of the neighbouring lynx populations would be affected.

(1 mark)

any one of:

- gene pool increases in size due to introduction of more alleles/genes into the population
- gene pool may increase in diversity due to introduction of new/different alleles/genes into the population
- number of genes in the population increases
- number of variations in gene pool may increase

- e. Lynx have lustrous, long hair. Currently lynx fur is out of fashion in the clothing industry, and a pelt sells for \$60.00. In 1987, when long-haired fur was in high demand, a single lynx pelt sold for \$1 100.00. When lynx fur is out of fashion, predict the change in environmental resistance on the hare population and the corresponding effect on hare population growth.

(1 mark)

Environmental resistance increases (since ER is a collection of factors, consideration of one factor such as predation needs to be linked to ER).

(1 mark)

Hare population decreases or population growth slows.

- f. The birth rate in the lynx population can be estimated by determining litter sizes. Litter size can be determined by two methods. The first method involves counting the number of placental scars on the uterus of a lynx carcass. A scar is left at each implantation site of a fetus. The second method involves counting the number of degenerated corpora lutea (plural of corpus luteum) in the ovaries of the lynx carcass. Neither of these methods provides a completely accurate value for litter size.

Explain why each method produces an **overestimation** of actual litter size.

- i. counting placental scars

any one of:

- (1 mark) i. • placental scars are produced by implantations, but not all implantations result in births (e.g. spontaneous abortions)
• reabsorption of embryos due to stressful conditions (or diseases associated with the reproductive systems)
• scars on the uterus other than those caused by a placenta

- ii. counting degenerated corpora lutea

any one of:

- (1 mark) ii. • not all eggs released are fertilized
• not all embryos will implant
• implantation does not ensure successful birth (e.g. spontaneous abortions)

- g. The procedures described in f. above involve the study of lynx carcasses. **Describe** one technology that **ecologists** use to collect data on any **live** animals.

a description of one of:

- (1 mark)
- capture, tag, recapture
 - radio transmitters/tags
 - satellite detection using transmitters
 - aerial photographs
 - binoculars
 - scat analysis (biopsies, tooth, blood analyses. . .)
 - tranquilizer gun
 - barbed wire (DNA analysis)

Use this additional information to answer the next question.

Lynx mate in March and have litters of 3 to 5 kittens in May. Lynx kittens are born blind and naked. Their eyes open after 10 days. In 12 weeks, the kittens travel with their mother. They watch and learn how to hunt for hares. Their eyesight is more acute than their hearing or sense of smell. Lynx are active at night (nocturnal).

Hares have litters of 2 to 4 offspring, with up to 4 litters over a summer. Hares are born with their eyes open and bodies fully haired. Birth weight doubles in 8 days. Hares use their good hearing and supersensitivity to ground vibrations, as well as speed and coordination, to escape lynx. Hares are active at night and spend the day grooming and resting.



Hare

Alberta Recreation, Parks and Wildlife



Lynx

Alberta Recreation, Parks and Wildlife

(The lynx is 10x larger than the hare)

- h. Classify the lynx as an *r*- or K-selected species. Provide **evidence from the information given** to support your choice.

(1 mark) K-selected

any one of:

- (1 mark)**
- born defenseless, helpless, etc.
 - time invested in young (travel with mother, watch and learn, parental care)
 - reproduce once a year (March)
 - only 3-5 kittens per year
 - only 1 litter per year
 - lynx are large (see comparison)

References:

Marty, S. (1995, September/October). The Lynx and the Hare. *Canadian Geographic*.

Poole, K.G. (1992). *Lynx Research in the Northwest Territories, 1991-92*. Manuscript Report No. 68. Government of the NWT.

Use the following information to answer the next question.

Humans gather information from their internal and external environment, sometimes with the assistance of various technologies. This information is interpreted, integrated, and communicated with appropriate body structures to bring about necessary responses.

Some of these responses maintain an internal equilibrium or homeostasis in the human body. Other responses allow survival in the external world and the ability to deal with stressful situations. In order to respond to any change in the environment (internal and external), the body employs structures called sensory receptors. All receptors function in a similar way: they convert some form of energy into a nerve impulse.

In 1936, Hans Selye, a Canadian endocrinologist, proposed the *general adaptation syndrome*, which describes the human response to stress. One phase of the syndrome is the alarm reaction that prepares the body for fight-or-flight. A second phase of the syndrome is the body's response to long-term stress.

Written Response – 15% (12 marks)

- 2.** Write a **unified** essay that describes **a stressful experience**; explain how the body responds to this stress by addressing the following aspects of neural processing.
- Identify at least **two** sensory organs that respond to external stimuli, and indicate the exact **location** within the organ where the sensory reception takes place. **Trace** the pathway of neural impulses to the brain thereby informing you of the stress.
 - Identify **body systems** that are affected by the stressful experience you described. Describe **physiological responses** controlled by these systems that help the body cope with this stress.
 - Describe **two** technologies that would assist or enhance sensory perception or help you deal with the stress you described.

Scoring Guide for Question 2

Stressful Experience

A student's response should identify a true-life situation (real or imagined) that can be detected with the senses, such as a frightening situation or physical trauma.

Information from External Environment & Pathway to Brain

Organ	Location of Reception	Pathway	Location in Brain for Sense Interpretation
Eye	Retina (rods & cones)	Optic nerve	Occipital lobe
Ear	Cochlea (hair cells) Semicircular canals (hair cells) Vestibule (hair cells)	Cochlear (Auditory nerve) Vestibular nerve (sensory neurons)	Primarily temporal lobe Cerebrum Cerebrum
Tongue	Taste buds (taste cells)	Sensory neuron	Parietal lobe (sensory cortex)
Nose	Olfactory epithelium (upper inside surface of nose)	Sensory neuron	Primarily temporal lobe
Skin	Various receptors in skin (pain, temperature, pressure, touch. . .)	Sensory neuron	Parietal lobe (sensory cortex)

Body Systems and Physiological Responses

Nervous system - ANS; the sympathetic nerves are involved

Organ:

- pupil of eye (nervous system)
- heart (circulatory system)

- intestine (digestive system)
- salivary glands (digestive system)
- stomach glands (digestive system)
- lungs (gas exchange system)
- blood vessels: (circulatory system)
 - gas exchange system
 - heart
 - skin
 - stomach
- metabolism (endocrine system)

Physiological coping response:

dilates
accelerates, increases output,
increases blood pressure
decreases movement
decreases secretion
decreases secretion
air passages dilate

dilates
dilates
constricts
constricts
increases

Endocrine system - Adrenal medulla produces epinephrine and norepinephrine in response to stress, which affect:

Organ:

- heart (circulatory system)

- blood vessels: (circulatory system)
 - skin
 - stomach & intestine
 - reproductive organs
 - muscles
- liver (digestive system)
- pituitary
- adrenal cortex

Physiological coping response:

accelerates
increases cardiac output
increases blood pressure

constricts
constricts
constricts
dilates
increase glucose release
releases ACTH and ADH
releases cortisol
releases aldosterone

Other hormones released:

- cortisol (ACTH)

- aldosterone (ACTH)
- ADH

increased blood sugar
suppression of immune and allergic responses
elevated blood pressure
increased water retention and
increased blood pressure (important in trauma)

Circulatory system – Local constriction of blood vessels or inflammatory response – histamine release

Technology in Sensory Perception

The student's response could include a **description** of at least two of the following topics:

- Hearing aids, audio tapes, sign language, etc. used as aids for the hearing impaired
- Replacing the bones of the middle ear
- Glasses, contact lenses, night vision glasses (heat sensors/infrared)
- Cornea and/or lens transplants
- Braille books, computers, guide dogs, etc. used as aids for the blind or visually impaired
- Artificial pressure receptors placed in prosthetic devices for the arms and legs

Accept other reasonable descriptions of technologies.

OR

Technology in Coping

The student's response could include a **description** of at least two of the following topics:

- Biofeedback (acupressure, acupuncture) reduces blood pressure, heart rate, increase relaxation
- Medicine (sedative, sleeping pills)
- Medicinal herbs (ginseng, hops, chamomile, lemon balm)
- Exercise (exercise program and relaxation exercises)
- Nutritional therapy (avoiding caffeine, alcohol, eating a diet high in complex carbohydrates)
- Yoga, meditation, and hypnosis
- Diversion type activities (listening to music, etc.)
- Aromatherapy
- Protective clothing to deal with the elements (sunglasses)
- Protective equipment to remove the stress (fire extinguisher)

Accept other reasonable descriptions of technologies.