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Grade 12 Diploma Examination

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June 2000

Biology 30

Grade 12 Diploma Examination

Description

Time: This examination was developed to be completed in 2.5 h; however, 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

This exam 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.

Note: *The 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

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

Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.
(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

Record 3214 on the answer sheet

3	2	1	4
•	•		
0	0	0	0
1	1	●	1
2	●	2	2
●	3	3	3
4	4	4	●
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Selection Question and Solution

The birds in the following list are numbered _____.
(Record your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

- 1 dog
- 2 sparrow
- 3 cat
- 4 robin
- 5 chicken

Answer 245

Record 245 on the answer sheet

2	4	5	
•	•		
0	0	0	0
1	1	1	1
●	2	2	2
3	3	3	3
4	●	4	4
5	5	●	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

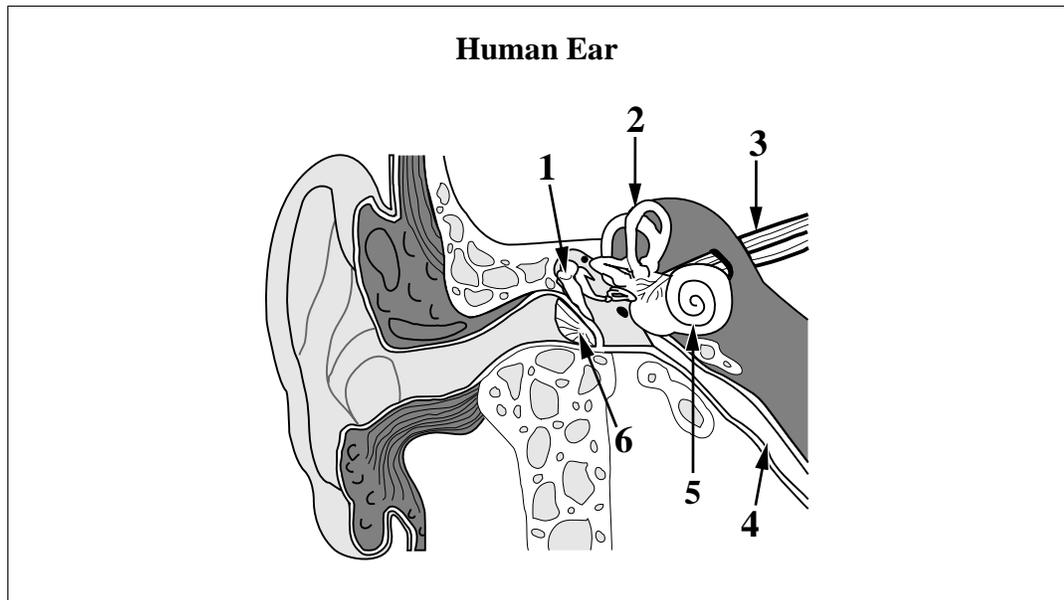
Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must address **all** aspects of the question.
- Descriptions and/or explanations of concepts must be correct and include pertinent ideas, diagrams, calculations, and formulas.
- Your answers must be presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.

Additional Instructions for Students Using Word Processors

- Keep all work together. Diagrams, graphs, calculations, etc. should be placed directly on your word-processed pages.
- Staple your final printed work to the page indicated for each word-processed response.
- Indicate in the space provided on the back cover that you attached word-processed pages.

Use the following information to answer the first two questions.



1. After riding the Tilt-A-Turn at an amusement park, people are often dizzy. Which of the structures numbered above is initially stimulated to cause the sensation of dizziness?
 - A. Structure 1
 - B. Structure 2
 - C. Structure 3
 - D. Structure 5

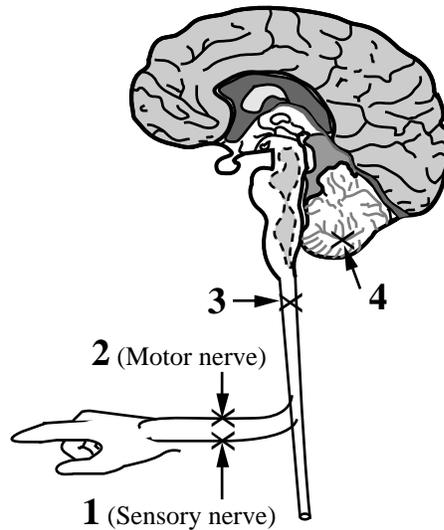
2. Which of the structures numbered above function together to convert sound waves to mechanical vibrations, and then to amplify these vibrations?
 - A. Structures 6 and 1
 - B. Structures 5 and 2
 - C. Structures 6 and 3
 - D. Structures 5 and 4

Use the following information to answer the next three questions.

A man was injured in an automobile accident. There appeared to be damage to his back, his arm, and his head.

A doctor examined the man, noted some symptoms, and hypothesized that nerve damage had occurred.

Some Possible Locations of Nerve Damage



3. Which of the following rows correlates possible observations about the accident victim with locations of nerve damage?

Row	Possible Observations	Locations of Nerve Damage
A.	The man could not move his wrist and could not feel sensations from his hand.	1 and 2
B.	The man could move his wrist normally but could not feel sensations from his hand.	1 and 4
C.	The man could not move his wrist but could feel sensations from his hand.	2 and 3
D.	The man could move his wrist normally and could feel sensations in his hand.	2 and 4

4. If, following the accident, the man exhibited a marked change in personality, the doctor would suspect damage to the
- A. medulla
 - B. cerebrum
 - C. cerebellum
 - D. hypothalamus

Use the following additional information to answer the next question.

Research has shown that although interneurons in the spinal cord make proteins that inhibit regeneration of damaged axons, peripheral nerve axons can regenerate.

5. The structure that allows neurons of peripheral nerves to regenerate is the
- A. axon
 - B. dendrite
 - C. neurilemma
 - D. node of Ranvier

Use the following information to answer the next two questions.

A laboratory technician was asked to set up an experiment to determine the effect of thyroxine on metabolic rate. Four groups of adult male laboratory rats were used. Each group was placed in the same type of cage, which was designed to provide room for physical activity. Each of the four groups was given an adequate supply of water and one of the four diets listed below:

Diet W: rat chow, a preparation of rat food containing all essential nutrients

Diet X: rat chow containing a chemical that counteracts the effect of thyroxine in the body

Diet Y: rat chow containing dried thyroid tissue, which contains thyroxine

Diet Z: rat chow deficient in iodine

The technician was not aware of which diet she was feeding to each group of rats. The following data were obtained:

Group	Average Initial Weight (g)	Average Final Weight After Two Weeks (g)	Final Average Oxygen Consumption (mL/kg•min)
I	323	392	2.5
II	328	287	10.0
III	330	400	2.0
IV	315	320	4.0

6. According to the data table, which group of rats was **most likely** the control group?

- A. I
- B. II
- C. III
- D. IV

7. The row below that correctly identifies two groups of laboratory rats and the diets they were most probably fed is

Row	Group	Diet	Group	Diet
A.	I	Z	II	W
B.	I	W	IV	X
C.	II	Y	III	X
D.	III	Z	IV	Y

Use the following information to answer the next three questions.

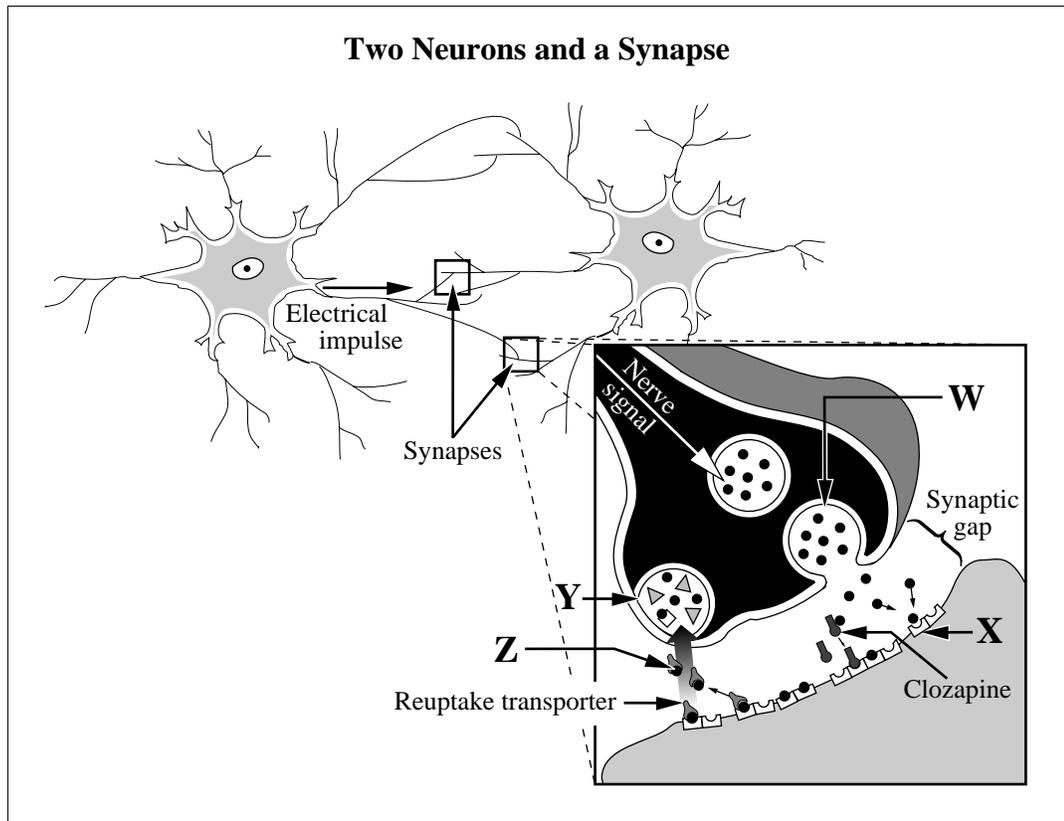
Serotonin is a naturally occurring neurotransmitter that plays an important role in a person's mood and emotions. A shortage of serotonin has been associated with phobias, schizophrenia, aggressive behaviour, depression, uncontrolled appetite, and migraine headaches. Synthetic drugs have been developed to enhance or hinder the performance of serotonin in the brain. Some of these drugs include:

- I** Prozac and Zoloft, which cause serotonin to remain in the brain for longer periods of time
- II** Drugs, such as Clozapine, that prevent serotonin from binding to post-synaptic membranes
- III** Diet drugs, such as Redux and Fenfluramine, that stimulate nerve cells to release more serotonin
- IV** Hallucinogens, such as LSD and Ecstasy, that react directly with serotonin receptors to produce the same effect as serotonin

—from *Lemonick, 1997*

8. The drugs numbered above that would act as competitive inhibitors to serotonin and the drugs that would slow down the rate of removal of serotonin from the synapse are, respectively,
- A. I and III
 - B. II and I
 - C. II and III
 - D. III and IV
9. If a person were suffering from clinical depression, which of the following drugs would **not** reduce the symptoms of depression?
- A. LSD
 - B. Zoloft
 - C. Clozapine
 - D. Fenfluramine

Use the following additional information to answer the next question.

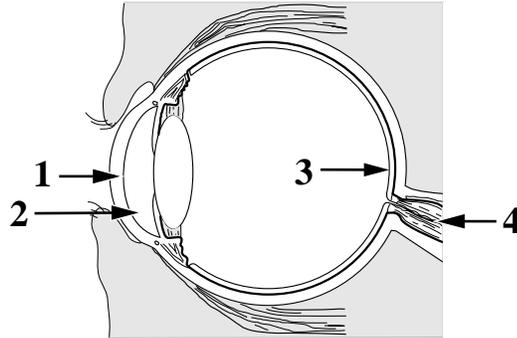


10. The row below that identifies the structure that releases serotonin and the section of the neuron that this structure is found in is

Row	Released from structure	Found in the
A.	W	axon terminal
B.	X	dendrite
C.	Y	axon terminal
D.	Z	dendrite

Use the following information to answer the next two questions.

Many scientists believe that sleep cycles are influenced by the hormone melatonin. Two scientists have shown that the retinas in hamsters are involved in maintaining a 24-hour cycle. Their research shows that impulses sent from the retina to the brain after exposure to light influence the secretions of melatonin. Melatonin is normally produced in greater amounts at night when the eyes are exposed to less light. In humans, melatonin produces drowsiness.



—from *Raloff, 1996*

11. Melatonin secretion decreases when light stimulates receptors found in the structure labelled
- A. 1
 - B. 2
 - C. 3
 - D. 4

Use the following additional information to answer the next question.

Scientists have discovered that, in many mammals, light exposure affects schedules of reproduction. Decreased light exposure in early winter results in a decrease in fertility in these mammals.

—from *Norman and Litwack, 1997*

12. Increased melatonin release due to decreased light exposure would reduce fertility in female mammals if it
- A. caused an increase in the secretion of LH
 - B. caused an increase in the secretion of FSH
 - C. stimulated the release of hormones from the pituitary
 - D. prevented the release of gonadotropin-releasing hormones from the hypothalamus

Use the following information to answer the next three questions.

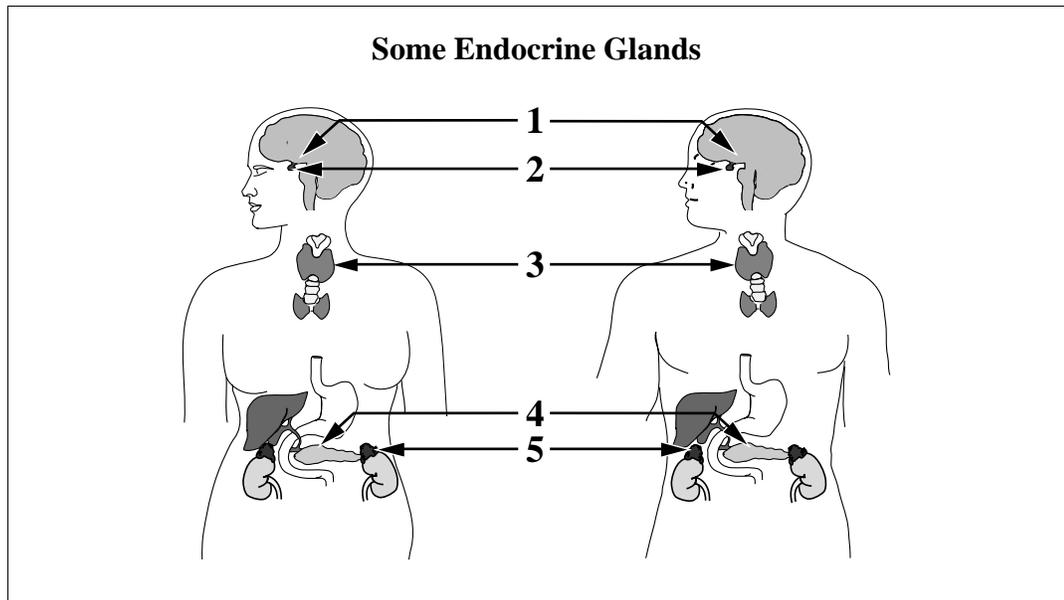
Researchers have been studying the connection between maternal care and stress in rats. Those rats that received more licking and grooming as babies release lower levels of ACTH in response to stress as adults. In humans, high levels of stress hormones are linked to an increase in heart disease, diabetes, depression, and alcoholism.

—from *Strauss, 1997*

13. In this study, the manipulated variable, responding variable, and a possible fixed (controlled) variable are given in row

Row	Manipulated Variable	Responding Variable	Fixed Variable
A.	amount of licking by mother rats	amount of ACTH released in adult rats	rats' cage size
B.	amount of ACTH released in adult rats	amount of licking by mother rats	age of mother rats
C.	amount of stress in environment	amount of ACTH released in adult rats	amount of licking by mother rats
D.	amount of licking by mother rats	heart disease in adult rats	amount of ACTH released in adult rats

Use the following additional information to answer the next question.



14. Humans, as well as rats, release ACTH in response to stress. The row below that identifies the gland that secretes ACTH and the target gland of ACTH in humans is

Row	Secreting Gland	Target Gland
A.	1	2
B.	1	3
C.	2	4
D.	2	5

15. When a person, or a rat, is exposed to stressful situations, the response of the nervous system is the activation of the
- A. sympathetic nervous system and the release of epinephrine by post-ganglionic fibres
 - B. sympathetic nervous system and the release of acetylcholine by post-ganglionic fibres
 - C. parasympathetic nervous system and the release of epinephrine by post-ganglionic fibres
 - D. parasympathetic nervous system and the release of acetylcholine by post-ganglionic fibres

Use the following information to answer the next four questions.

A series of experiments initially designed to study the effects of fathers' drinking habits on fetal development produced some unexpected results.

Seventy-five male rats were injected with enough alcohol to produce a 0.2% concentration of alcohol in their blood. After 24 hours, these male rats were mated with 75 female rats not treated with alcohol. A control group of 75 untreated male rats were also mated with untreated female rats. Both sets of males copulated normally and with the same vigour.

The pregnancy rate of female rats mated with the alcohol-treated male rats was 50% lower than the pregnancy rate of female rats mated with untreated rats. Also, pup litters in the group with alcohol-treated males appeared to be smaller and individual pups weighed less.

Repetition of these experiments produced similar results.

—from *Fackelmann, 1994*

16. Fluids in rat semen bathe the egg and sperm for several days after fertilization. This fluid contains secretions from the
- A. prostate gland only
 - B. seminal vesicles only
 - C. urethra and seminal vesicles
 - D. Cowper's glands, prostate gland, and seminal vesicles
17. Reduction in pregnancy rates for rodent couples in the study group could have been caused by
- A. alcohol-treated males' inability to copulate normally
 - B. alcohol in the female's blood affecting egg production
 - C. alcohol in the male's blood increasing pituitary hormone secretions
 - D. alcohol in the semen fluids producing a poisonous environment for fertilization
18. Prolonged high concentrations of alcohol in the male would likely affect male fertility in all of the following ways **except** by
- A. reducing the rate of meiosis
 - B. preventing the maturation of sperm
 - C. depressing motility in sperm by damaging cells
 - D. stimulating motility in sperm by increasing metabolism

Use the following additional information to answer the next question.

Some Endocrine Glands and Hormones

- 1 pituitary
- 2 estrogen
- 3 testosterone
- 4 hypothalamus
- 5 FSH
- 6 seminal vesicle
- 7 LH
- 8 testis

Numerical Response

- 1.** To complete this statement, select the gland or hormone numbered above that **best** fills each blank.

The production of sperm in the male is directly stimulated by the hormone _____, which is produced in the _____, and by the hormone _____, which is produced in the _____.

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

Use the following information to answer the next question.

A five-month-old human female fetus produces approximately seven million developing ova (eggs) in her ovaries. Approximately 400 000 of these developing ova survive to puberty. Of these, approximately 400 will complete development and be released during a woman's lifetime.

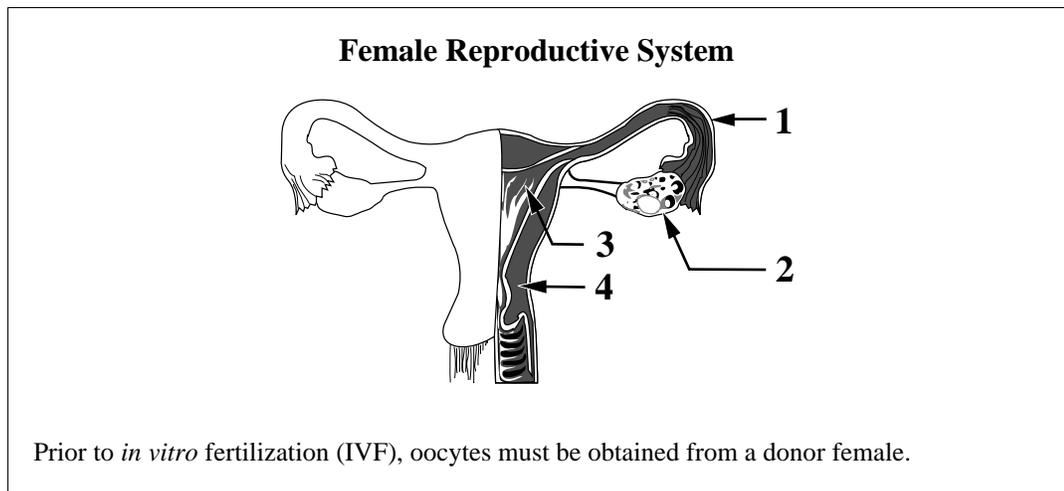
- 19.** This process is similar to spermatogenesis in males in that
- A. eggs and sperm are both diploid
 - B. eggs and sperm are both haploid
 - C. eggs and sperm are both produced before puberty
 - D. an equal number of both eggs and sperm reach maturity

Use the following information to answer the next four questions.

In order to initiate *in vitro* fertilization, a woman must undergo hormonal therapy to release numerous mature eggs and to prepare the uterine lining. The eggs are removed using a laparoscope and fertilized in a petri dish. The developing embryos are inserted back into the woman for implantation to take place.

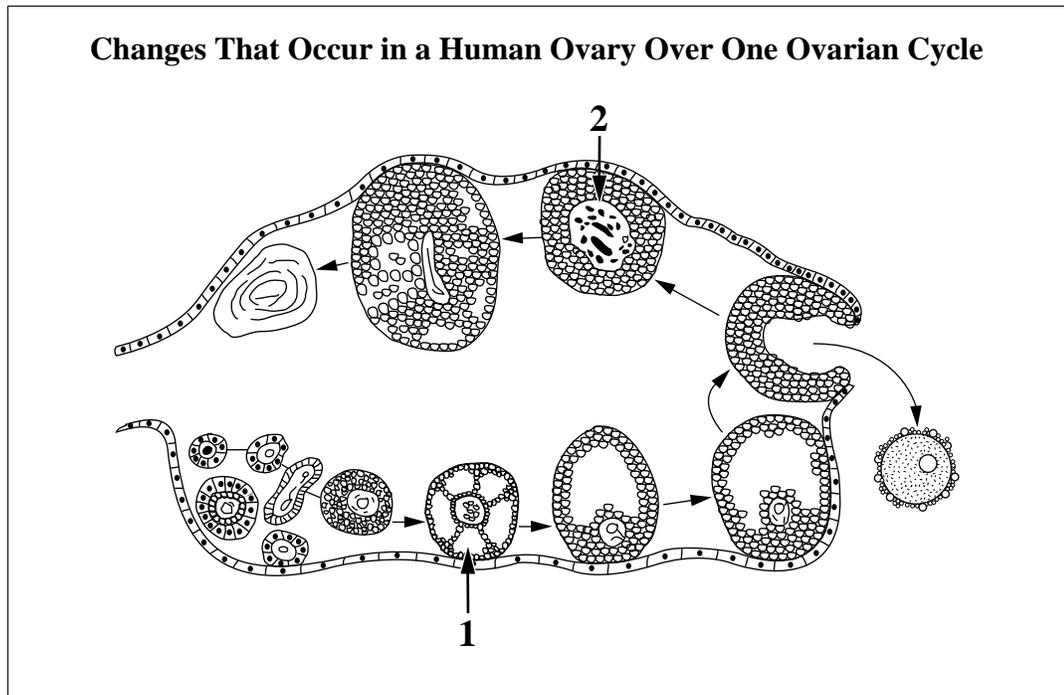
20. What hormone changes would cause a female to develop and release a large number of mature eggs?
- A. Increased FSH and LH
 - B. Decreased FSH and LH
 - C. Increased estrogen and progesterone
 - D. Decreased estrogen and progesterone

Use the following additional information to answer the next question.



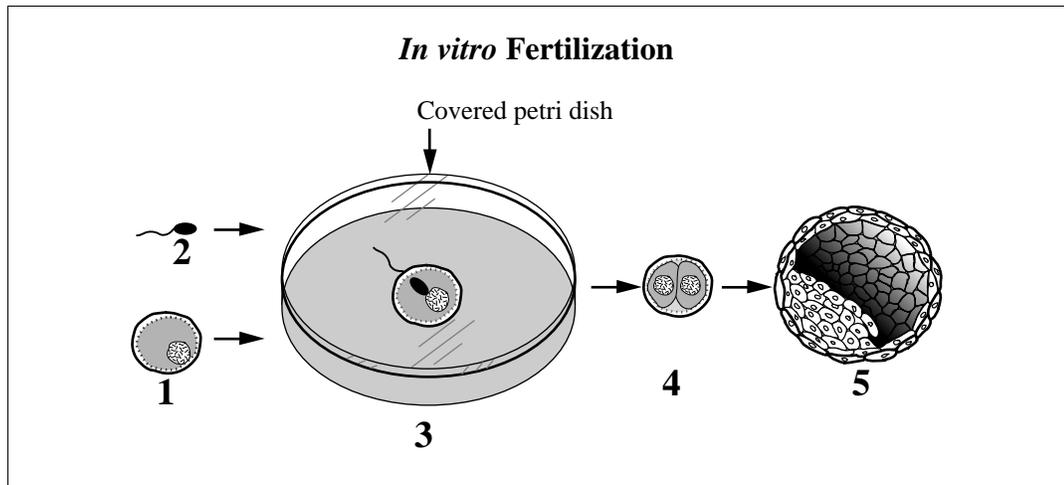
21. To obtain oocytes for *in vitro* fertilization, the structure numbered above that must be hormonally stimulated is
- A. 1
 - B. 2
 - C. 3
 - D. 4

Use the following additional information to answer the next question.



22. In order for artificial implantation to be successful, what hormone would a female need to take to maintain the uterine lining for implantation, and which of the structures of the ovary numbered above would naturally produce this hormone?
- A. Estrogen and structure 1
 - B. Estrogen and structure 2
 - C. Progesterone and structure 1
 - D. Progesterone and structure 2

Use the following additional information to answer the next question.



Numerical Response

2. Match the parts of the diagram numbered above that represent the terms given below.

Part of Diagram: _____
 Terms: Oocyte Blastocyst First mitotic division Fertilization

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

Use the following information to answer the next four questions.

A rare defect inherited by 19 descendants of a Dominican man named Altagracia Carrasco caused genetically male children to be considered female until age 12. At this age, hormone levels increased dramatically and caused the testes to descend from the abdomen to the scrotum and male primary and secondary sexual characteristics to develop.

In their Dominican Republic village, these people were given the name “guevedoces,” which means “penis at 12 years of age.”

—from Pringle, 1992

23. The “guevedoces” were genetically programmed at conception by a sperm with
- A. a Y chromosome fertilizing an egg with a Y chromosome
 - B. a Y chromosome fertilizing an egg with an X chromosome
 - C. an X chromosome fertilizing an egg with a Y chromosome
 - D. an X chromosome fertilizing an egg with an X chromosome

24. The “guevedoces” might have reduced fertility because the late descent of their testes would cause
- A. high production of testosterone
 - B. high production of progesterone
 - C. cell development problems in their follicular cells
 - D. cell development problems in their seminiferous tubules
25. The sex hormone that increased in these individuals at age 12 and a secondary sexual characteristic the individuals would develop as a result are, respectively,
- A. FSH and decreased body fat
 - B. testosterone and decreased breast size
 - C. testosterone and increased larynx size
 - D. FSH and increased muscle development

Use the additional information to answer the next question.

Stages in Development

- 1 Fetus has a beating heart
- 2 Embryo differentiates into three layers (gastrulation)
- 3 Blastocyst implants in endometrium
- 4 Cleavage (mitosis) leads to a large number of cells without growth

Numerical Response

3. The “guevedoces” embryonic and fetal development was normal except for their reproductive organs. Match each of the developmental stages numbered above with the time period in which it occurs, as given below.

Stage: _____
Time Period: **First week** **Second week** **Third week** **Fourth week**
and on

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

Use the following information to answer the next four questions.

A study published in the journal *Pediatrics* indicates that breast-fed infants have a substantially decreased risk of developing diarrhea compared with infants fed formula. Another study reported that although a majority of infants harbour populations of bacteria that would cause diarrhea in adults, breast-fed infants do not get sick. The bacterium *Clostridium difficile* produces a toxin that irritates the lining of the colon causing diarrhea. Breast milk contains a protein called secretory component that binds to the toxin, thus causing the toxin to be ineffective.

—from *J.T.*, 1997

26. The protein secretory component is produced in breast milk when
- A. DNA is translated
 - B. DNA is replicated
 - C. mRNA is translated
 - D. mRNA is replicated

Use the following additional information to answer the next three questions.

The human milk protein, secretory component, can be manufactured by transgenic sheep. The following steps are necessary for producing transgenic sheep.

1. The gene for secretory component is isolated and cloned into a vector.
2. Vectors carrying the gene are microinjected into fertilized sheep eggs, which are then implanted into female sheep.
3. Heterozygous transgenic offspring are identified.

27. The heterozygous offspring described above are next mated to non-transgenic sheep. If the allele for human secretory protein is s and the absence of the human gene is S , the symbolic representation of the cross is
- A. $ss \times ss$
 - B. $Ss \times ss$
 - C. $Ss \times SS$
 - D. $SS \times ss$

Numerical Response

4. The proportion of offspring from the mating of a heterozygous transgenic sheep and a non-transgenic sheep that are predicted to be heterozygotes is _____.

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

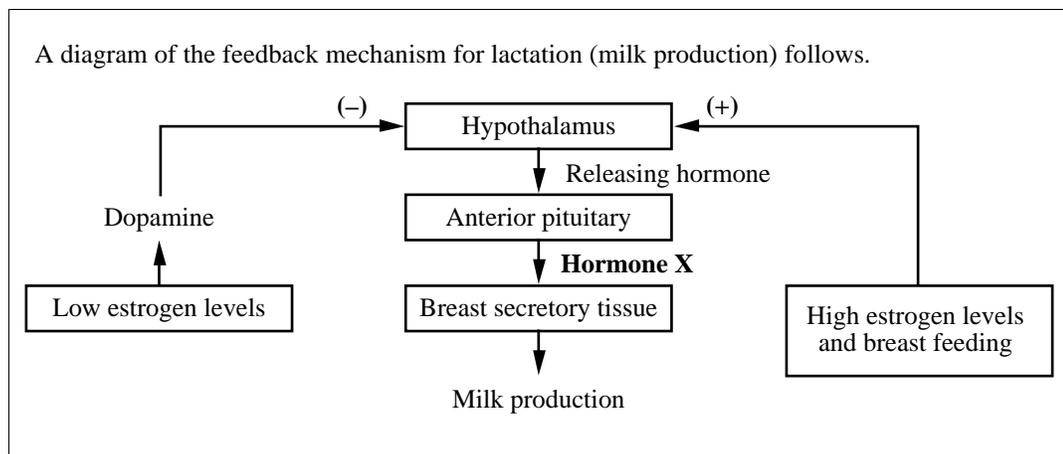
Numerical Response

5. The heterozygous offspring are then mated and their homozygous transgenic offspring are used for producing the milk product. Out of 220 offspring produced from these crosses, how many offspring are predicted to be transgenic homozygotes?

Answer: _____

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

Use the following information to answer the next two questions.

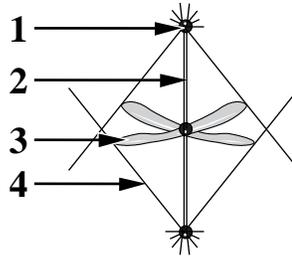


28. The reason males do not lactate even though they have breast tissue is that
- A. estrogen levels in males are too low to overcome the inhibiting action of dopamine
 - B. males do not need to produce milk, thus the breast tissue in males is not designed to produce milk
 - C. males have a Y chromosome, which has a gene that prevents the breast secretory tissue from producing milk
 - D. males have high levels of testosterone, which inhibits the pituitary from releasing the hormone that stimulates lactation
29. Hormone X, which initiates and maintains milk production in females, is
- A. estrogen
 - B. oxytocin
 - C. prolactin
 - D. progesterone

Use the following information to answer the next three questions.

Investigators were interested in determining the role chromosomes play in the formation of the mitotic spindle. Using extracts of eggs from the African frog *Xenopus laevis*, they monitored spindle assembly in a test tube. The researchers replaced the chromosomes with beads coated with random sequences of DNA. The beads served as substitute genetic material, but centrosomes (centrioles) were absent. As well, a part of the centromere was missing.

Simplified Diagram of Normal Mitotic Cell



—from Travis, 1996

30. Which of the structures numbered above was replaced by the beads in the experimental setup?
- A. 1
 - B. 2
 - C. 3
 - D. 4

Use the following additional information to answer the next question.

The investigators observed that the genetic material on the beads condensed and microtubules began to form. Within 90 minutes, the microtubules formed a spindle-like structure that lined up the beads along the centre of the cell.

—from Travis, 1996

31. Based on the results of this research, the structure or molecule that does **not** appear to be necessary for mitosis is
- A. DNA
 - B. a spindle
 - C. centrosomes
 - D. microtubules

Use the following additional information to answer the next question.

Other studies showed that the phase that involves pulling chromosomes to the two poles of mitotic cells can be delayed for up to 4.5 h by pulling a chromosome out of line from the centre of the cell.

—from *Travis, 1996*

32. The phase that is delayed and the phase where the chromosomes line up at the equator are, respectively,
- A. telophase and anaphase
 - B. metaphase and prophase
 - C. interphase and telophase
 - D. anaphase and metaphase
-

Use the following information to answer the next two questions.

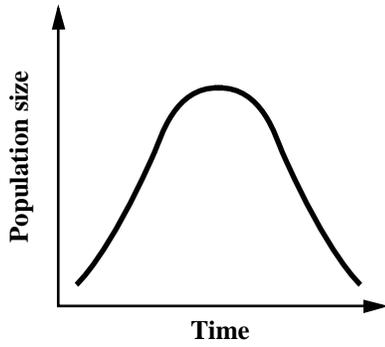
Cystic fibrosis is a recessive Mendelian trait in the human population. A symptom of cystic fibrosis is the production of large amounts of mucin protein. New studies indicate that although the cystic fibrosis condition is present at birth, increased mucin production is preceded by an infection with the bacterium *Pseudomonas aeruginosa*. Individuals who are not affected by cystic fibrosis produce a natural antibiotic, defensin, that kills the *Pseudomonas aeruginosa* and eliminates the stimulus for increased mucin production. Defensin is destroyed by a high chloride content in the tissues of individuals with cystic fibrosis as a result of faulty chloride-channel proteins.

—from *Sternberg, 1997*

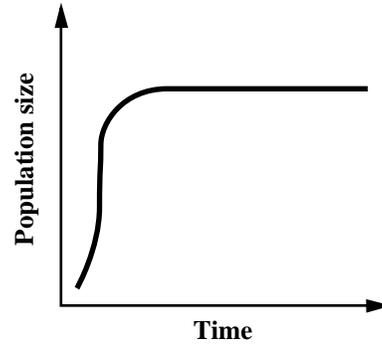
33. The allele that causes cystic fibrosis **most likely** results in a faulty amino acid sequence for the
- A. channel proteins
 - B. mucin molecules
 - C. defensin molecules
 - D. *Pseudomonas* bacteria

34. In a normal individual, the population of *Pseudomonas aeruginosa* exhibits which of the following population growth curves following initial infection of the individual?

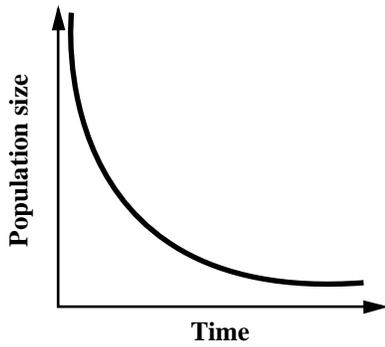
A.



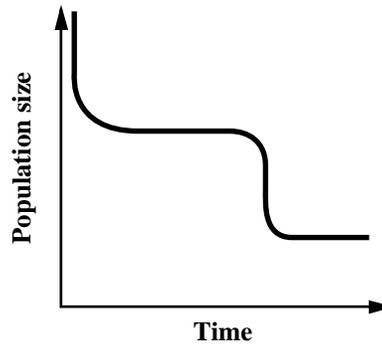
B.



C.



D.

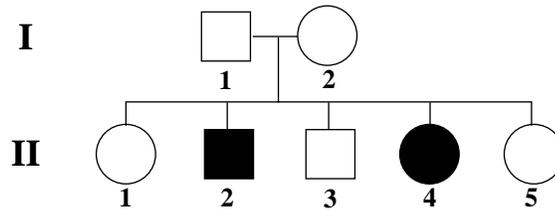


Use the following information to answer the next three questions.

Amniocentesis is a common prenatal procedure used to obtain cells to test for genetic abnormalities that lead to disorders such as Down syndrome, cystic fibrosis, and hemophilia. The test is usually offered between the 15th and 18th weeks of pregnancy to women who have an increased risk of having children with genetic abnormalities.

Use the following additional information to answer the next question.

Pedigree of a Family with Cystic Fibrosis



Note: Cystic fibrosis in this family is caused by a recessive allele that is found on chromosome 7.

35. Prior to performing amniocentesis, a genetic counsellor collected pedigree information regarding the incidence of cystic fibrosis within this family. The row that indicates the genotypes of individuals **I-1**, **I-2**, and **II-2** is

Row	I-1	I-2	II-2
A.	Aa	Aa	aa
B.	AA	aa	Aa
C.	X^AY	X^AX^A	X^aY
D.	X^AY	X^AX^a	X^AY

36. Down syndrome is a trisomy disorder that can be caused by the presence of three copies of chromosome 21. Which of the following chromosome combinations identifies Down syndrome?
- A. 46 chromosomes consisting of 45 autosomes and 1 sex chromosome
 - B. 46 chromosomes consisting of 44 autosomes and 2 sex chromosomes
 - C. 47 chromosomes consisting of 45 autosomes and 2 sex chromosomes
 - D. 47 chromosomes consisting of 44 autosomes and 3 sex chromosomes

37. A genetic abnormality such as Down syndrome can be diagnosed by using the cells obtained during amniocentesis to create a
- A. karyotype
 - B. therapeutic gene
 - C. DNA fingerprint
 - D. recombinant vector

Use the following information to answer the next two questions.

In humans, the allele for normal blood clotting, *H*, is dominant to the allele for hemophilia, *h*. The trait is X-linked.

38. A female hemophiliac marries a man who is not a hemophiliac. The row that indicates the probability of this couple having a child that is a hemophiliac and the sex that the child would be is

Row	Probability	Sex of Affected Child
A.	0.25	male
B.	0.25	either female or male
C.	0.50	male
D.	0.50	either male or female

Numerical Response

6. A woman who is not a hemophiliac has a father who is a hemophiliac. If this woman marries a man who is a hemophiliac, what is the probability of them having a hemophiliac son?

Answer: _____

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

Use the following information to answer the next four questions.

Two different genes control the expression of kernel colour in Mexican black corn: black pigment gene *B* and dotted pigment gene *D*. Gene *B* influences the expression of gene *D*. The dotted phenotype appears only when gene *B* is in the homozygous recessive state. A colourless variation occurs when both genes are homozygous recessive.

After pure-breeding black-pigmented plants were crossed with colourless plants, all of the offspring were black-pigmented.

—from Griffiths *et al.*, 1993

39. The genotypes of the parents of these F_1 offspring could be
- A. $BBDD \times bbdd$
 - B. $BbDD \times bbdd$
 - C. $Bbdd \times bbDD$
 - D. $bbDD \times BBdd$
40. Plants of the F_1 generation are suspected of being heterozygous for both genes. A test cross of colourless plants with the heterozygote plants should produce a phenotypic ratio in the offspring of
- A. 1 : 0
 - B. 3 : 1
 - C. 2 : 1 : 1
 - D. 1 : 1 : 1 : 1

Numerical Response

7. What is the probability of dotted offspring being produced from the test cross described above?

Answer: _____

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

Numerical Response

8. If the total number of offspring produced in the test crosses was 1 024 plants, how many plants would you expect to be black-pigmented?

Answer: _____

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

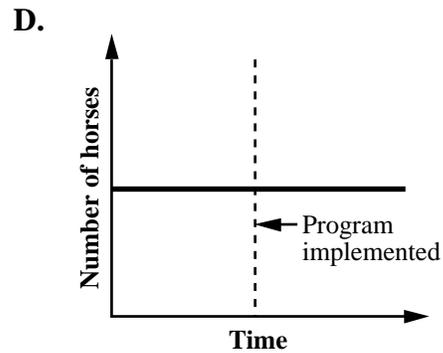
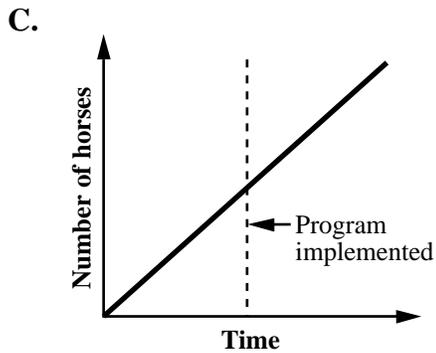
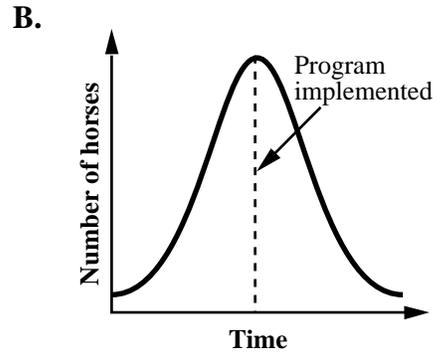
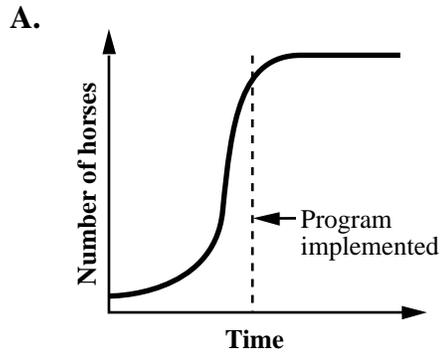
Use the following information to answer the next three questions.

The 42 000 wild horses and donkeys that live in the American West are reproducing at such a high rate that they could severely damage range lands in the future. In an effort to prevent overpopulation, some mares (females) are rounded up and injected with porcine zona pellucida (PZP), a long-lasting contraceptive. U.S. Food and Drug Administration guidelines prohibit the use of PZP until after a wild mare has had at least one successful pregnancy.

—from *McInnis, 1996*

41. If the effect of PZP on horses is like the effect of the birth control pill on women, pregnancy is prevented because
- A. ovulation does not occur
 - B. implantation does not occur
 - C. sperm cannot enter the uterus
 - D. sperm cannot enter the oviducts
42. Wild horses are considered to be a relatively K-selected species; however, one characteristic exhibited by these wild horses that is similar to an *r*-selected species is
- A. their large size
 - B. their relatively long lifespan
 - C. their relatively high reproductive potential
 - D. the large amount of parental care devoted to their offspring

43. Assuming that the contraceptive program manages the wild horse population successfully, which of the following graphs would **best** represent the wild horse population growth curve over time?



Use the following information to answer the next question.

Harbour porpoises living off the northeast coast of Scotland have been found dead washed up on shore, the victims of violent, high-energy impacts. Zoologists have identified scratches on the dead porpoises that match the teeth of an unlikely killer, the bottle-nosed dolphin, long assumed to be playful and gentle. These two cetaceans (aquatic mammals), which share the same range and food supply, were thought to coexist peacefully.

—from *Discover*, 1996

44. What type of relationship do the bottle-nosed dolphin and the harbour porpoise exhibit?
- A. Symbiotic
 - B. Predator-prey
 - C. Intraspecific competition
 - D. Interspecific competition

Use the following information to answer the next three questions.

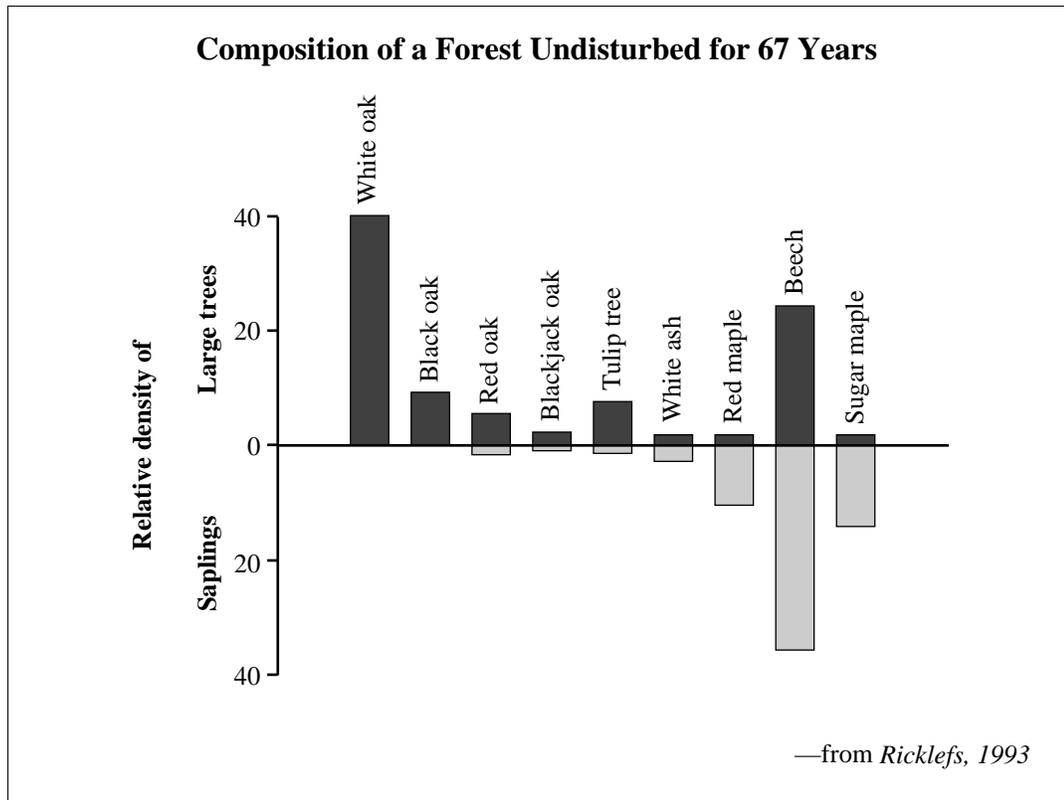
Pacific herring play a key role in the marine food web of Canada's West Coast. They are prey fish and comprise 30% to 70% of the summer diets of Chinook salmon, Pacific cod, lingcod, and harbour seals in the coastal waters of southern British Columbia. The eggs of Pacific herring are important to the diets of migrating sea birds, gray whales, and some invertebrates. Pacific herring are not mature enough to spawn until age three. Spawning takes place in coastal areas where algae beds are abundant and the water is uncontaminated.

45. Which of the following factors is an example of a density-independent factor that influences Pacific herring survival and growth?
- A. Algae populations
 - B. Ocean temperatures
 - C. Population of grey whales
 - D. Imposition of fishing quotas
46. In the mid-1960s, a combination of intense fishing harvests and unfavourable ocean conditions caused the Pacific herring population to decline drastically. Which of the following rows shows the changes in relationships, after this decline, that were probably exhibited among organisms that prey on the Pacific herring?

Row	Interspecific Competition	Intraspecific Competition
A.	decrease	decrease
B.	decrease	increase
C.	increase	decrease
D.	increase	increase

47. Salmon fishing is an important industry on the West Coast of Canada. If the salmon population were to decrease because of overfishing, the Pacific herring population would probably remain relatively stable if other predators showed which of the following changes?
- A. Increased mortality and decreased emigration
 - B. Decreased mortality and increased emigration
 - C. Increased mortality and decreased immigration
 - D. Decreased mortality and increased immigration

Use the following information to answer the next question.



48. In which of the following ways would you expect this forest to change in the next 50 years?
- A. The relative density of all trees will increase.
 - B. There will be an emergence of coniferous trees such as spruce or pine.
 - C. There will be an increase in the relative density of beech and a decrease in the relative density of white oak.
 - D. The relative density of blackjack oak, white ash, red maple, and sugar maple will decrease as a result of competition from the larger trees.

Use the following information to answer the next question.

Acquired immune deficiency syndrome (AIDS) research has centred on developing drug treatments and an AIDS vaccine. AIDS is caused by human immunodeficiency virus (HIV). The drug AZT can greatly reduce the chance of transmission of HIV from an infected woman to her unborn child. The current AZT treatment is very costly. To make the treatment more affordable, African researchers have conducted a number of studies in which one group of HIV infected women was given a shorter than normal course of AZT treatments and another group of HIV infected women received a placebo (pill without medication).

A vaccine made from only the outer coating of the HIV is attached to a harmless virus. The vaccine is being tested on healthy human volunteers to see whether they develop antibodies that would help them produce a natural defence against AIDS. This type of vaccine has not yet been sufficiently effective to induce the desired immunity. A similar AIDS vaccine tested in Canada did not work any better than a placebo.

Future treatments for AIDS may be based on newly acquired knowledge of how AIDS infection occurs and why some individuals are more resistant to infection. When body cells are damaged, they produce a protein (chemokine) to attract the body's immune cells (macrophages). The macrophages have receptors on their cell membranes that attach to the chemokine and rid the body of the damaged cells. The HIV attaches to one kind of chemokine receptor (CCR5) on the macrophage and enters the macrophage, but the HIV does not destroy it. Ultimately, the virus also infects T-cells and takes over their DNA replicating mechanisms. The macrophage infection may be necessary to activate the replicating mechanisms of T-cells.

It has been discovered that some people have inherited a resistance to HIV because the gene that makes the CCR5 receptor is mutated (missing 32 nucleotides). This CCR5 mutation results in a shorter receptor, thereby preventing the HIV from attaching to macrophages. Individuals in a study group who were homozygous for the mutant allele resisted infection despite many exposures to HIV. Individuals in the study group with one copy of the mutant allele had the onset of AIDS postponed for two to three years when compared with those in the study group that had no copies of the mutant allele. The mutated allele is most common in Caucasians.

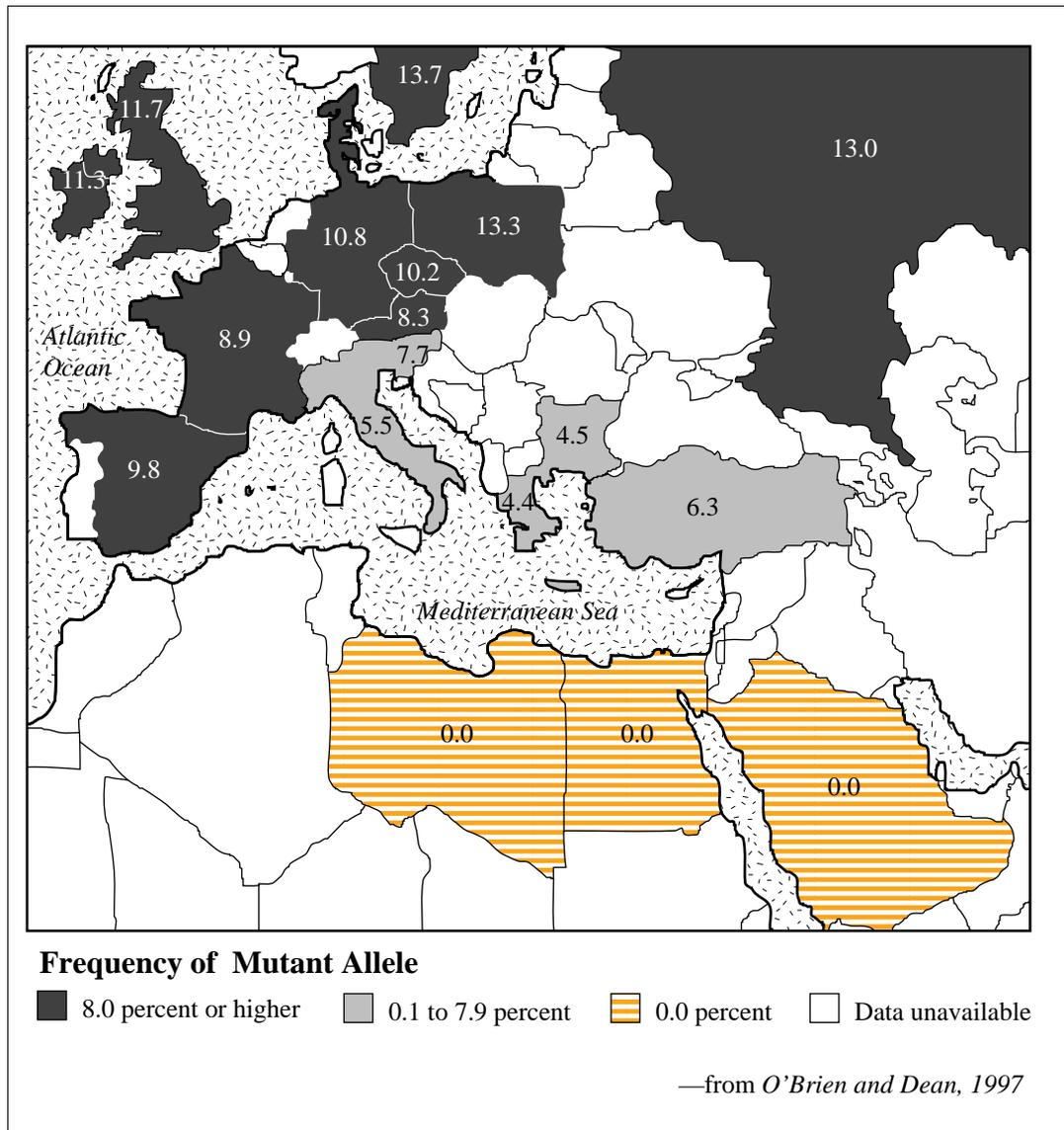
—from *Day, 1997*
O'Brien and Dean, 1997

Written Response – 15%

Staple your word-processed response for **this** question to this page.

- 1.** a. i. Using your knowledge of how experiments should be designed, explain why some African woman were given a placebo instead of the AZT drug. **(1 mark)**

Use the additional information to answer the next three parts of the question.



- d. Hypothesize why the northern European population has a much higher frequency of the CCR5 mutant allele than the African population. (2 marks)

Use the additional information to answer the next part of the question.

Frequency of the Mutated CCR5 Allele in Various Populations	
Population	Frequency of Mutant Allele
Caucasian–European	0.100
Caucasian–American	0.111
African–American	0.017
Native American, African, East Asian	0.000

- e. What percentage of the Caucasian–American population would be heterozygous for the mutated CCR5 allele? Show all work and formulas. **(2 marks)**
- f. The discovery of how the mutant CCR5 allele works to make a person resistant to HIV infection has led scientists to work on new ways to treat or prevent AIDS. Describe a scientific technology that could be used to treat or prevent AIDS that utilizes this new knowledge. **(2 marks)**

Use the following information to answer the next question.

Human growth hormone (HGH) stimulates the growth of bones and muscles and also has insulin-like properties that result in the deposition of fat in body tissues. Sometimes, for medical purposes, an individual is prescribed a supplement of HGH. Unfortunately, at high levels, HGH has some unpleasant side effects. At a high dosage, HGH can cause insensitivity to insulin. In extreme cases, permanent diabetes mellitus can result.

Dr. J.F. Mueller made an interesting discovery. He observed that mice infected with the plerocercoid larvae of the tapeworm *Spirometra mansonioides* showed accelerated growth. Careful analysis revealed that the larvae produced plerocercoid growth factor (PGF) that is remarkably similar to HGH in structure and function. Further study showed PGF to be molecularly similar to HGH, but it had no anti-insulin effect.

How is it that a tapeworm larva produces a substance so similar to HGH? Even closely related animals have quite different hormones, so it is not likely that this is a chance occurrence. One hypothesis that has been suggested involves viral transduction of the HGH gene. When a virus infects a host cell, the viral DNA becomes incorporated into the host DNA. Later, the host cell is tricked into assembling new viruses. The viral DNA is replicated and placed in the new viruses. Sometimes a section of host DNA is added along with the viral DNA. If the new virus infects a second host, the second host receives the DNA from the first host. This host-to-host transfer of DNA is called viral transduction.

The life cycle of the tapeworm allows it to easily infect not only humans but several other vertebrates. Almost all tapeworms are hermaphrodites (contain both male and female sex organs). Multiple testes and ovaries found in segments on a single tapeworm produce gametes that come together and result in the production of fertilized eggs (either by self-fertilization or cross-fertilization). The fertilized eggs are released into the intestine of the final host and leave the host through the feces. The host's fecal matter enters the water system where the eggs hatch into ciliated coracidia (hair-covered circular organisms). The coracidia are eaten by small crustaceans called copepods. Copepods are ingested by fish, mice, cats, humans, and other organisms that drink the contaminated water. Once inside the new host, each coracidium may develop into a pleurocercoid larva that forms a cyst in the muscle. When this host is eaten by another animal, the pleurocercoid larva attaches to the small intestine wall and develops the reproductive segments of the adult tapeworm.

—from *Barnard and Behnke, 1990*;
Phares, 1987

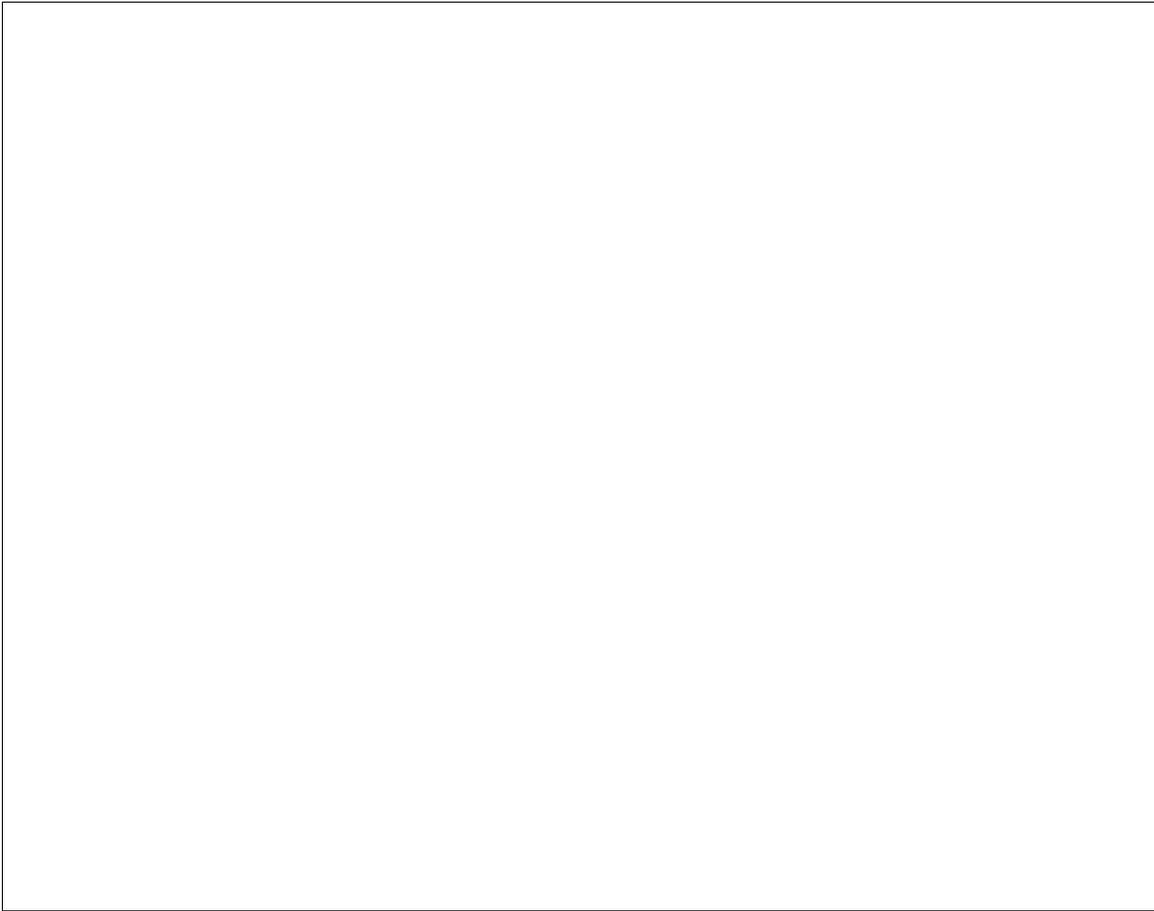
Written Response – 15%

Staple your word-processed response for **this** question to this page.

2. Write a unified response that addresses the discovery of the PGF protein in tapeworms and its potential use in science and medicine.

- **Draw** a diagram of the tapeworm life cycle, indicating the timing of important cell divisions such as mitosis and meiosis. **Explain** the value of these two types of cell divisions as they apply to the tapeworms.
- **Describe** the series of steps that would have to occur in order for the gene for HGH to end up in tapeworm DNA as hypothesized.
- **Describe** the disorder that results from not having enough HGH during childhood development. Treatment could involve the use of PGF instead of HGH. **Identify** specific effects that make it advantageous to use PGF instead of HGH.

Use the following space for your diagram.



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References

- MC 8–10 Lemonick, M.D. 1997. The mood molecule. *Time*, 29 September, 55–62.
- MC 11–12 Raloff, J. 1996. Eyes possess their own biological clocks. *Science News* 149(4): 245.
- MC 12 Norman, W. and G. Litwack. 1997. *Hormones*. San Diego: Academic Press.
- MC 13–15 Strauss, S. 1997. Kisses and chemistry linked in rats. *The Globe and Mail*, 12 September.
- MC 16–18 Fackelmann, K.A. 1994. Male rats find alcohol a fertility downer. *Science News* 146(1): 6.
NR1
- MC 23–25 Pringle, H. 1992. The sex difference. *Equinox*, September/October, 84–86.
NR 3
- MC 26–27 J.T. 1997. The benefits of mother’s milk. *Science News* 151(5): 322.
NR4–NR5
- MC 30–32 Travis, J. 1996. Mitotic mischief: Can cells divide without chromosomes? *Science News* 150(8): 140–141.
- MC 33–34 Sternberg, S. 1997. Cystic fibrosis puzzle coming together. *Science News* 151(2): 85.
- MC 39–40 Griffiths, A.J., et al. 1993. *Genetic Analysis*. New York: W.H. Freeman and
NR 7–8 Company.
- MC 41–43 McInnis, D. 1996. Birth control reins in wild horses’ foaling around. *Edmonton Journal*,
14 April.
- MC 44 Breakthroughs. 1996. Killer dolphins. *Discover* 17(9): 22.
- O’Brien, S.J. and M. Dean. 1997. In search of AIDS-resistance genes. *Scientific American*.
275(9): 44–51.
- WR 2 Barnard, C.J. and J.M. Behnke. 1990. *Parasitism and Host Behavior*. New York: Taylor
and Francis.
- Phares, C.K. 1987. Pleurocercoid growth factor: A homologue of human growth hormone.
Parasitology Today 3(11): 346–348.

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- WR 1 Map by Laurie Grace. Adapted from *Scientific American*, 275(9): 49. Reprinted by
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BIOLOGY DATA

Symbols

Symbol	Description
D_p	population density
N	numbers of individuals in a population
A	area, space, or volume occupied by a population
t	time
Δ	change
r	biotic potential OR maximum per capita population growth rate
K	carrying capacity
$\frac{\Delta N}{\Delta t}$	a 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

Equations

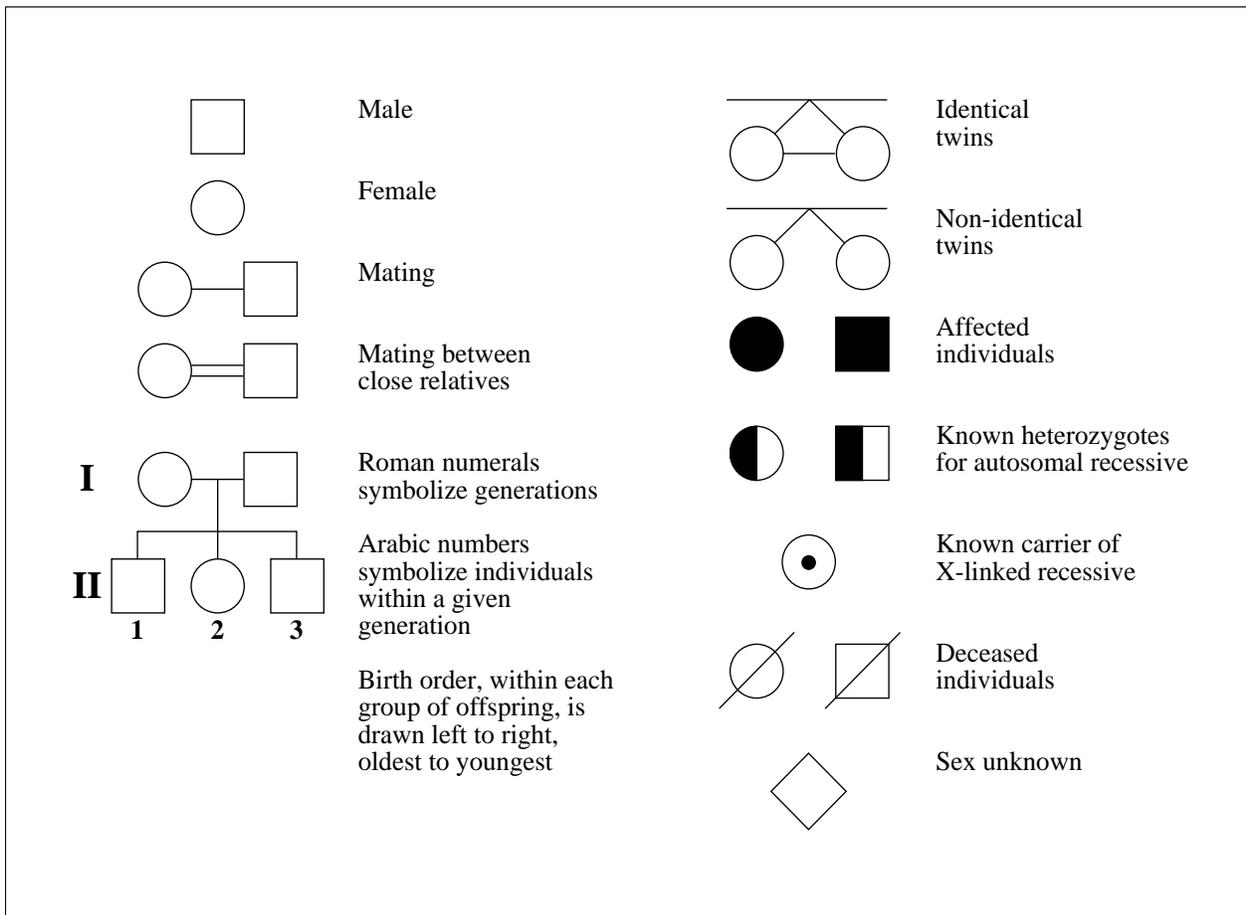
Subject	Equation
Hardy–Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta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

Fold and tear along perforation.

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



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 and 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.

No marks will be given for work done on this page.

Fold and tear along perforation.

***Biology 30
Diploma Examination
June 2000***

***Multiple–Choice Key,
Numerical–Response Key,
and
Sample Answers to
Written–Response Questions***

**Biology June 2000 Diploma Examination
Multiple Choice and Numerical Response Keys**

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

1. 3851 or 5138

2. 1543

3. 4321

4. 0.50

5. 55

6. 0.25

7. 0.25

8. 512

Biology 30 June 2000 Diploma Examination Scoring Guide

Use the following information to answer the next question.

Acquired immune deficiency syndrome (AIDS) research has centred on developing drug treatments and an AIDS vaccine. AIDS is caused by human immunodeficiency virus (HIV). The drug AZT can greatly reduce the chance of transmission of HIV from an infected woman to her unborn child. The current AZT treatment is very costly. To make the treatment more affordable, African researchers have conducted a number of studies in which one group of HIV infected women was given a shorter than normal course of AZT treatments and another group of HIV infected women received a placebo (pill without medication).

A vaccine made from only the outer coating of the HIV is attached to a harmless virus. The vaccine is being tested on healthy human volunteers to see whether they develop antibodies that would help them produce a natural defence against AIDS. This type of vaccine has not yet been sufficiently effective to induce the desired immunity. A similar AIDS vaccine tested in Canada did not work any better than a placebo.

Future treatments for AIDS may be based on newly acquired knowledge of how AIDS infection occurs and why some individuals are more resistant to infection. When body cells are damaged, they produce a protein (chemokine) to attract the body's immune cells (macrophages). The macrophages have receptors on their cell membranes that attach to the chemokine and rid the body of the damaged cells. The HIV attaches to one kind of chemokine receptor (CCR5) on the macrophage and enters the macrophage, but the HIV does not destroy it. Ultimately, the virus also infects T-cells and takes over their DNA replicating mechanisms. The macrophage infection may be necessary to activate the replicating mechanisms of T-cells.

It has been discovered that some people have inherited a resistance to HIV because the gene that makes the CCR5 receptor is mutated (missing 32 nucleotides). This CCR5 mutation results in a shorter receptor, thereby preventing the HIV from attaching to macrophages. Individuals in a study group who were homozygous for the mutant allele resisted infection despite many exposures to HIV. Individuals in the study group with one copy of the mutant allele had the onset of AIDS postponed for two to three years when compared with those in the study group that had no copies of the mutant allele. The mutated allele is most common in Caucasians.

—from *O'Brien and Dean, 1997*

Written Response – 15%

Staple your word-processed response for **this** question to this page.

- 1.** a. i. Using your knowledge of how experiments should be designed, explain why some African woman were given a placebo instead of the AZT drug. **(1 mark)**

The women taking the placebo are the control group (used as a comparison with the women taking AZT).

or

A placebo is used to determine if the psychological effects of treatment (taking a pill) are causing any observed changes.

- ii. Why could it be considered ethically wrong to give one group of African women a placebo in place of the real AZT treatments? **(1 mark)**

Doctors should do everything in their power to help people with known diseases, especially if there is a chance of transmission to others.

- b. Describe how it is physically possible for a pregnant woman with AIDS to pass the virus to her fetus. **(1 mark)**

Viruses are small enough to pass through the placental membranes from maternal blood to the fetal blood. (1 mark)

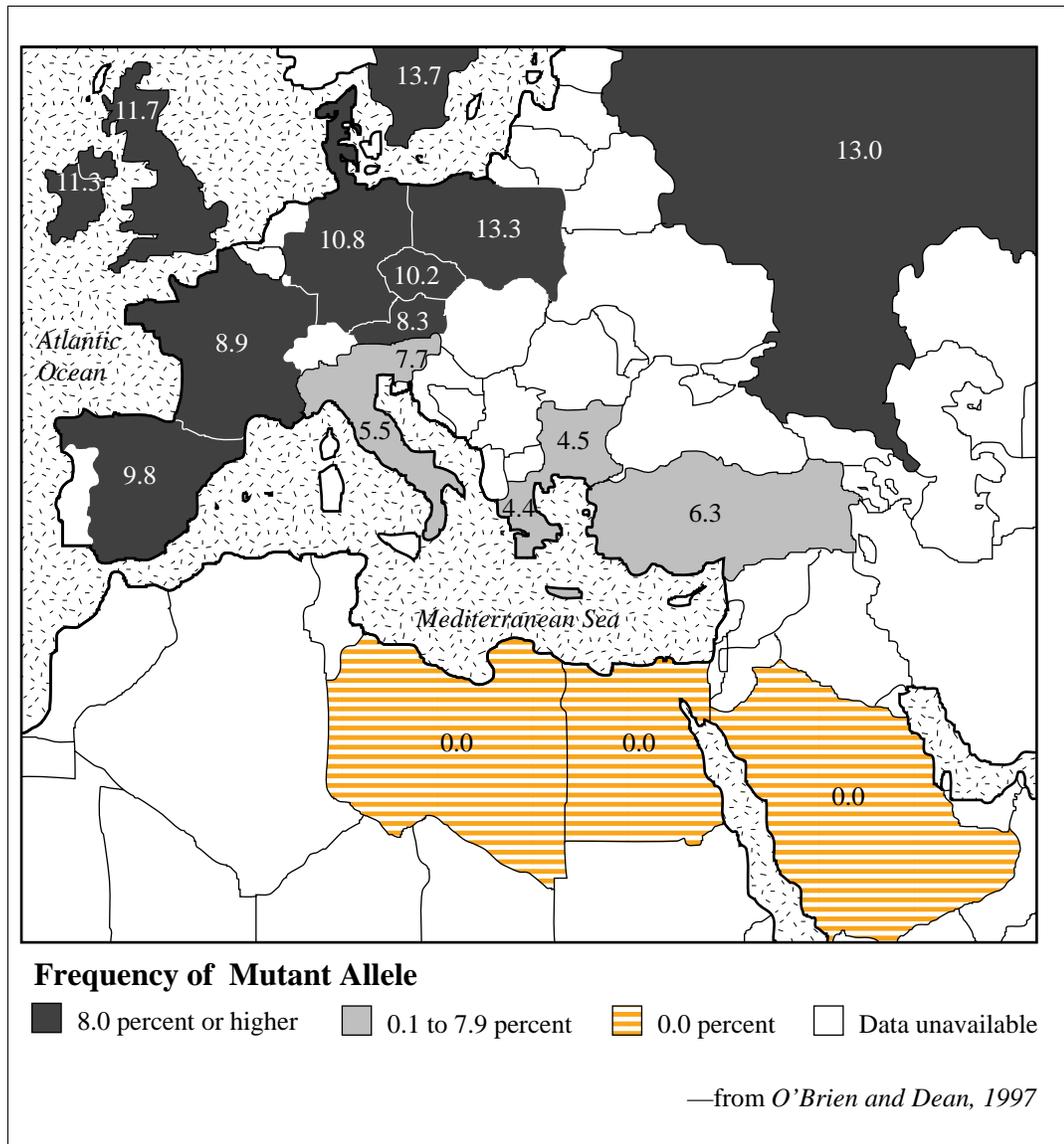
or

HIV can directly infect the baby at birth since there is a possibility of maternal/fetal blood contact. (1 mark)

- c. Describe briefly the cellular mechanisms of transcription, translation, and protein synthesis that are involved in the production of the CCR5 receptor molecule. **(3 marks)**

The mutated DNA gene is transcribed into an mRNA molecule. The mRNA molecule leaves the nucleus and attaches to a ribosome in the cytoplasm. The mRNA is translated into a sequence of amino acids based on the three base codons of the mRNA molecule. Amino acids are brought to the ribosome by tRNA molecules which have anti-codons to complement the mRNA codons. Amino acids join together to form the protein (CCR5 receptor molecule).

Use the additional information to answer the next three questions.



- d. Hypothesize why the northern European population has a much higher frequency of the CCR5 mutant allele than the African population. (2 marks)

There may have been a epidemic of a infection similar to the HIV in northern Europe generations ago. Without treatment, many people would have died. People with a mutant CCR5 allele would have a selective advantage over people without the allele therefore increasing its frequency.

or

The mutated CCR5 allele occurred in an European individual originally. The geographic isolation or reproductive isolation of the European people maintained the allele in Europe until recent times. (Founder effect) (Bottleneck effect)

Use the additional information to answer the next question.

Frequency of the Mutated CCR5 Allele in Various Populations	
Population	Frequency of Mutant Allele
Caucasian–European	0.100
Caucasian–American	0.111
African–American	0.017
Native American, African, East Asian	0.000

- e. What percentage of the Caucasian–American population would be heterozygous for the mutated CCR5 allele? Show all work and formulas. (2 marks)

$$\begin{aligned}p + q &= 1 \\q &= .111 \\p &= .889 \\2pq &= .197 \\&\text{so } 19.7\% \text{ or } 20\%\end{aligned}$$

Marks:

1 mark: correct work shown

1 mark: correct answer calculated

- f. The discovery of how the mutant CCR5 allele works to make a person resistant to HIV infection has led scientists to work on new ways to treat or prevent AIDS. Describe a scientific technology that could be used to treat or prevent AIDS that utilizes this new knowledge. (2 marks)

Possible Technologies are:

- Use genetic engineering to introduce the CCR5 mutant allele into the macrophages thereby preventing the HIV from attaching to them.
- Drugs or chemicals that would plug the CCR5 receptors and prevent the HIV from binding onto these sites.
- A vaccine made of fragments of CCR5 receptors that could induce the recipient's immune system to produce its own CCR5 binding antibodies.

Or any other reasonable answer.

Use the following information to answer the next question.

Human growth hormone (HGH) stimulates the growth of bones and muscles and also has insulin-like properties that result in the deposition of fat in body tissues. Sometimes, for medical purposes, an individual is prescribed a supplement of HGH. Unfortunately, at high levels, HGH has some unpleasant side effects. At a high dosage, HGH can cause insensitivity to insulin. In extreme cases, permanent diabetes mellitus can result.

Dr. J.F. Mueller made an interesting discovery. He observed that mice infected with the plerocercoid larvae of the tapeworm *Spirometra mansonioides* showed accelerated growth. Careful analysis revealed that the larvae produced plerocercoid growth factor (PGF) that is remarkably similar to HGH in structure and function. Further study showed PGF to be molecularly similar to HGH, but it had no anti-insulin effect.

How is it that a tapeworm larvae produces a substance so similar to HGH? Even closely related animals have quite different hormones, so it is not likely that this is a chance occurrence. One hypothesis that has been suggested involves viral transduction of the HGH gene. When a virus infects a host cell, the viral DNA becomes incorporated into the host DNA. Later, the host cell is tricked into assembling new viruses. The viral DNA is replicated and placed in the new viruses. Sometimes a section of host DNA is added along with the viral DNA. If the new virus infects a second host, the second host receives the DNA from the first host. This host-to-host transfer of DNA is called viral transduction.

The life cycle of the tapeworm allows it to easily infect not only humans but several other vertebrates. Almost all tapeworms are hermaphrodites (contain both male and female sex organs). Multiple testes and ovaries found in segments on a single tapeworm produce gametes that come together and result in the production of fertilized eggs (either by self-fertilization or cross-fertilization). The fertilized eggs are released into the intestine of the final host and leave the host through the feces. The host's fecal matter enters the water system where the eggs hatch into ciliated coracidia (hair-covered circular organisms). The coracidia are eaten by small crustaceans called copepods. Copepods are ingested by fish, mice, cats, humans, and other organisms that drink the contaminated water. Once inside the new host, each coracidium may develop into a pleurocercoid larva that forms a cyst in the muscle. When this host is eaten by another animal, the pleurocercoid larva attaches to the small intestine wall and develops the reproductive segments of the adult tapeworm.

—from *Barnard and Behnke, 1990*;
Phares, 1987

Written Response – 15%

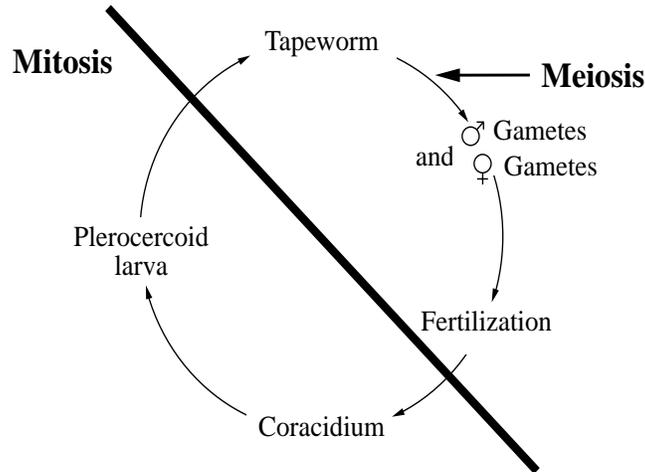
Staple your word-processed response for **this** question to this page.

- 2.** Write a unified response that addresses the discovery of the PGF protein in tapeworms and its potential use in science and medicine.

Suggest Answers

- **Draw** a diagram of the tapeworm life cycle, indicating the timing of important cell divisions such as mitosis and meiosis. **Explain** the value of these two types of cell divisions as they apply to the tapeworms.

Life Cycle



Meiosis in a tapeworm results in haploid sperm and egg cells. This is necessary before a sperm and egg can recombine to form a diploid cell. Meiosis makes fertilization possible which recombines genetic information to produce variation in a population. Variations allow individuals in the population to survive under varying conditions.

Mitosis allows for growth of the tapeworm and repair of tissues in a tapeworm. It maintains all the instructions in the original cell since the cells produced are identical. The tapeworm also changes forms in various hosts to exploit various environments. Mitosis makes these changes possible.

- **Describe** the series of steps that would have to occur in order for the gene for HGH to end up in tapeworm DNA as hypothesized.

Incorporation of HGH Gene Into Tapeworm

A virus entered a human body cell and its DNA became incorporated into the human DNA. By chance, the viral DNA became incorporated close to the human gene for HGH. When the human DNA began replicating viral DNA, the HGH was replicated as well and became a part of the viral genome.

The virus mutated in such a way as to allow it to enter the reproductive cells of a tapeworm gamete. Once inside a tapeworm cell, the viral genetic information became incorporated into the tapeworm DNA. The gene for HGH then became part of that tapeworm's DNA. Since it was a gamete, this altered gene would be passed on to subsequent generations of tapeworms.

- **Describe** the disorder that results from not having enough HGH during childhood development. Treatment could involve the use of PGF instead of HGH. **Identify** specific effects that make it advantageous to use PGF instead of HGH.

Dwarfism and Treatment

*Lack of HGH during childhood development results in the disorder known as **dwarfism**. Children with dwarfism develop at a greatly reduced rate, however body proportions are relatively normal. At puberty children who lack HGH have long bones that are greatly reduced in length, and hence they are dwarfs as adults.*

Advantages of using PGF instead of human HGH.

- *produces growth in a similar way to HGH*
 - *does not cause insensitivity to insulin*
 - *no risk in leading to diabetes*
 - *blood glucose would not elevate; other diabetic symptoms would not occur*
- Or any other reasonable response*

Science

Score	Scoring Criteria
<p style="text-align: center;">5 Excellent</p>	<p>The student...</p> <ul style="list-style-type: none"> • draws an accurate tapeworm life cycle diagram that includes most of the following: gametes, fertilized egg, coracidium, plerocercoid and adult tapeworm. Mitosis and meiosis are clearly and correctly indicated on the diagram. • clearly describes the value of mitosis and meiosis to a tapeworm. • clearly describes the three necessary steps in the transfer of the human growth hormone gene to a tapeworm.
<p style="text-align: center;">4 Proficient</p>	<ul style="list-style-type: none"> • draws a tapeworm life cycle diagram that is fairly complete and correctly indicates mitosis and meiosis on the diagram or draws an accurate tapeworm lifecycle with mitosis or meiosis indicated on the diagram. • clearly describes the value of either mitosis or meiosis and partially describes the value of either mitosis or meiosis. • clearly describes two of the three steps in the transfer of the HGH gene to a tapeworm or partially describes all three steps.
<p style="text-align: center;">3 Satisfactory</p>	<ul style="list-style-type: none"> • draws a tapeworm life cycle diagram that is partially complete and correctly indicates mitosis or meiosis on it or clearly draws an accurate tapeworm life cycle diagram. • clearly describes the value of either mitosis or meiosis or partially describes the value of both mitosis and meiosis. • clearly describes one of the three steps in the transfer of the HGH gene to a tapeworm or partially describes two steps.
<p style="text-align: center;">2 Limited</p>	<ul style="list-style-type: none"> • attempts a tapeworm life cycle diagram or describes when mitosis or meiosis occurs. • partially describes the value of either mitosis or meiosis. • partially describes one of the steps in the transfer of a human gene to another organism.
<p style="text-align: center;">1 Poor</p>	<ul style="list-style-type: none"> • addresses only one of the three bullets at a 3 or 2 level.

INSUFFICIENT is a special category. It is not an indication of quality. It should be assigned to papers that do not contain a discernible attempt to address the questions presented in the assignment or that are too brief to assess in this or any other scoring category.

Technology and Society

Score	Scoring Criteria The student...
<p style="text-align: center;">5 Excellent</p>	<ul style="list-style-type: none"> • clearly describes dwarfism and identifies two advantageous effects of using PGF in its treatment.
<p style="text-align: center;">4 Proficient</p>	<ul style="list-style-type: none"> • describes dwarfism and identifies one advantageous effect of using PGF and suggests one advantageous effect or partially describes dwarfism and identifies two advantageous effects of using PGF in its treatment.
<p style="text-align: center;">3 Satisfactory</p>	<ul style="list-style-type: none"> • partially describes dwarfism and identifies one advantageous effect of using PGF or identifies two advantageous effects of using PGF in treatment of low HGH or clearly describes dwarfism.
<p style="text-align: center;">2 Limited</p>	<ul style="list-style-type: none"> • identifies or partially describes dwarfism and suggests one advantageous effect of using PGF in its treatment or identifies one advantageous effect of using PGF to treat low HGH.
<p style="text-align: center;">1 Poor</p>	<ul style="list-style-type: none"> • identifies or partially describes dwarfism or suggests one advantageous effect of using PGF to treat low HGH.

INSUFFICIENT is a special category. It is not an indication of quality. It should be assigned to papers that do not contain a discernible attempt to address the questions presented in the assignment or that are too brief to assess in this or any other scoring category.