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June 2001

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 calculator. You may use any scientific calculator or a graphing calculator approved by Alberta Learning.
- You are expected to have cleared your calculator of all information that is stored in the programmable or parametric memory.
- 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.
**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. science  
D. chemistry

Answer Sheet

● B C D

---

**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 one decimal place in the numerical-response section on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3  
= 23.666…  
= 23.7 (rounded to one decimal place)

Record 23.7 on the answer sheet: [2 3 7]
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

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

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.

Between seven and 12 months of age, infants begin to display a marked fear of strangers. Infants also begin to socially reference their responses during the same period. Some research indicates that extremely fearful children often have very anxious parents.

1. The division of the nervous system that is directly responsible for physiological responses to fear is the
   A. sensory nervous system
   B. somatic nervous system
   C. sympathetic nervous system
   D. parasympathetic nervous system

Use the following additional information to answer the next question.

Biofeedback consists of conscious efforts to control body responses that are normally involuntary. This technique can be used to control abnormal fear.

2. Conscious efforts to control body responses through biofeedback originate in the
   A. medulla
   B. cerebrum
   C. cerebellum
   D. hypothalamus
Use the following information to answer the next four questions.

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3. During the cloning of a fetal pig’s brain cells, the cells underwent the process of **i**, which increased their numbers, and after injection into people with Parkinson’s disease, the cells produced dopamine when the **ii** code for it was translated.

The row that completes the statement above is row

<table>
<thead>
<tr>
<th>Row</th>
<th>i</th>
<th>ii</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>meiosis</td>
<td>DNA</td>
</tr>
<tr>
<td>B.</td>
<td>meiosis</td>
<td>mRNA</td>
</tr>
<tr>
<td>C.</td>
<td>mitosis</td>
<td>DNA</td>
</tr>
<tr>
<td>D.</td>
<td>mitosis</td>
<td>mRNA</td>
</tr>
</tbody>
</table>

4. The drugs levadopa and seligiline are similar in that they both

A. require cloning  
B. act as inhibitors  
C. prevent the death of neurons  
D. increase neurotransmission in the brain
5. Which of the following rows correctly identifies the substances that correspond to X, Y, and Z in the diagram above?

<table>
<thead>
<tr>
<th>Row</th>
<th>Dopamine</th>
<th>Seligiline</th>
<th>Monoamine Oxidase B</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>X</td>
<td>Y</td>
<td>Z</td>
</tr>
<tr>
<td>B.</td>
<td>Z</td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>C.</td>
<td>Z</td>
<td>Y</td>
<td>X</td>
</tr>
<tr>
<td>D.</td>
<td>X</td>
<td>Z</td>
<td>Y</td>
</tr>
</tbody>
</table>

6. A possible reason for the link between smoking and a reduced risk of developing Parkinson’s disease is that smoking
   A. reduces the level of dopamine and MAO B
   B. increases the level of dopamine and MAO B
   C. reduces the level of dopamine by increasing the level of MAO B
   D. increases the level of dopamine by decreasing the level of MAO B
Use the following information to answer the next question.

Individuals know that touching a hot stove can be painful. When an individual accidentally touches a hot stove, a reflex arc is initiated, which causes the person to withdraw his or her hand before he or she senses the pain.

7. Which of the following lists identifies the neural pathway in a reflex arc?
   A. Receptor, sensory neuron, effector, motor neuron
   B. Motor neuron, interneuron, sensory neuron, effector
   C. Sensory neuron, receptor, interneuron, motor neuron
   D. Receptor, sensory neuron, interneuron, motor neuron

Use the following information to answer the next question.

Alternative medicine, such as aromatherapy, is becoming increasingly popular in western society. Aromatherapy uses natural oils and plant extracts. The scents of the oils and extracts are inhaled or the fragrant oils are massaged into the skin. Proponents of aromatherapy hypothesize that odours affect the brain and its release of neurochemicals. These neurochemicals may then relieve pain.

**Hypothesized Steps in Aromatherapy Action**

1. Olfactory neurons depolarize.
2. Olfactory receptors are stimulated.
3. Neurochemicals affect pain interpretation.
4. Neurochemicals are released from axon terminals.

**Numerical Response**

1. If it is assumed that the hypothesis is correct, the order in which the steps above would occur to result in pain relief in a person having just inhaled the scent from an aromatherapy oil or extract is ____, ____, ____, and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)
8. The area of the brain that controls the sympathetic and parasympathetic nervous systems is labelled

A. 1  
B. 2  
C. 3  
D. 4
Erectile dysfunction is defined as the inability to maintain an erection adequate enough to achieve a satisfactory sexual experience. When erectile dysfunction is related to inadequate blood flow to the penis, the medication Viagra can be prescribed.

A side effect of Viagra is that it sometimes results in temporary difficulties in distinguishing between the colours of blue and green. For this reason, pilots have been banned from using the drug within six hours of a flight.

The Human Eye

9. The cells in the eye that are affected by Viagra and the primary location of these cells, as labelled above, are, respectively,
   A. rod cells and location 1
   B. rod cells and location 2
   C. cone cells and location 1
   D. cone cells and location 2

10. Viagra could be prescribed to treat impotence in males with
    A. normal levels of GMP but low levels of PDE5
    B. low levels of GMP but normal levels of PDE5
    C. high levels of GMP but normal levels of GMP receptors
    D. normal levels of GMP but high levels of GMP receptors
Erectile dysfunction can result in the inability of a couple to conceive. However, infertility is more commonly associated with insufficient sperm production. The feedback loop below illustrates the hormonal control of sperm production.

11. In the diagram above, the hormones FSH, LH, and testosterone are labelled, respectively,

A. 2, 3, 4  
B. 2, 3, 5  
C. 3, 2, 4  
D. 3, 2, 5

12. If infertility were due to decreased production of hormone 1 by the hypothalamus, then fewer sperm would be produced because there would be

A. low levels of hormone 2  
B. high levels of hormone 3  
C. high levels of hormone 4  
D. low levels of hormone 5
Use the following information to answer the next four questions.

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13. Two manipulated variables in this study are
   A. sex and spatial skills
   B. test scores and spatial skills
   C. sex and testosterone levels
   D. test scores and testosterone levels

14. Based on the results shown in the graph above, the effect that administering extra testosterone to females and males will have on their respective spatial skills is shown in row

<table>
<thead>
<tr>
<th>Row</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>improved</td>
<td>improved</td>
</tr>
<tr>
<td>B.</td>
<td>weakened</td>
<td>improved</td>
</tr>
<tr>
<td>C.</td>
<td>improved</td>
<td>weakened</td>
</tr>
<tr>
<td>D.</td>
<td>weakened</td>
<td>weakened</td>
</tr>
</tbody>
</table>
15. The cells that produce testosterone in females and in males are given in row

<table>
<thead>
<tr>
<th>Row</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>follicle cells</td>
<td>interstitial cells</td>
</tr>
<tr>
<td>B.</td>
<td>adrenal cortex cells</td>
<td>interstitial cells</td>
</tr>
<tr>
<td>C.</td>
<td>follicle cells</td>
<td>seminiferous tubule cells</td>
</tr>
<tr>
<td>D.</td>
<td>adrenal cortex cells</td>
<td>seminiferous tubule cells</td>
</tr>
</tbody>
</table>

Use the following additional information to answer the next question.

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**Statements Related to Women’s Hormonal Levels and Skill Levels**

1. Increased testosterone and increased estrogen increase a woman’s spatial skills.
2. Increased testosterone and decreased estrogen increase a woman’s spatial skills.
3. During pregnancy, a woman’s spatial skills are enhanced.
4. During pregnancy, a woman’s motor skills are enhanced.
5. During pregnancy, a woman’s articulation skills are reduced.
6. A woman’s spatial skills are enhanced around day 1 of her menstrual cycle.
7. A woman’s motor skills are enhanced around day 14 of her menstrual cycle.
8. A woman’s mathematical skills are enhanced around day 14 of her menstrual cycle.

**Numerical Response**

2. This research supports the four statements numbered _____, _____, _____, and _____.

(Record your four-digit answer from lowest to highest numeric order in the numerical-response section on the answer sheet.)
16. The concept that is **most strongly** supported by this discovery is that

A. genes are involved in enzyme production that influences learning
B. genes are involved in enzyme production that controls stimuli creation
C. learning is a wholly inherited trait and is not influenced by the environment
D. learning is not an inherited trait and is wholly influenced by the environment

17. The incidence of prostate cancer is likely highest in men who are

A. homozygous for the normal allele
B. homozygous for the allele variation
C. heterozygous, because these men produce both versions of the enzyme
D. heterozygous, because these men produce neither version of the enzyme

18. Possible DNA triplets for valine and leucine are identified in row

<table>
<thead>
<tr>
<th>Row</th>
<th>Valine</th>
<th>Leucine</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>CAT</td>
<td>GTG</td>
</tr>
<tr>
<td>B.</td>
<td>CAA</td>
<td>GAA</td>
</tr>
<tr>
<td>C.</td>
<td>GTT</td>
<td>CTT</td>
</tr>
<tr>
<td>D.</td>
<td>GUU</td>
<td>CUC</td>
</tr>
</tbody>
</table>
Use the following information to answer the next two questions.

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19. Which of the following pieces of evidence would indicate that the male examined in this study did not experience a genetic mutation in his gonadal cells but more likely inherited the condition?

A. Azoospermia is found in 3% to 4% of males.
B. The DAZ gene once deleted can never be regained.
C. Deletion of the DAZ gene occurs more commonly during meiosis.
D. Both blood cells and sperm of the subject were lacking the DAZ gene.

20. If a male with azoospermia were to father sons through in vitro fertilization, what percentage of his sons would be expected to have azoospermia?

A. 0%
B. 25%
C. 50%
D. 100%
Use the following information to answer the next three questions.

Ideas concerning the nature of inheritance have very early origins, but the conceptual breakthrough that established modern genetics as a science was made less than 150 years ago by an Austrian monk, Gregor Mendel.

21. Alternate forms of the same gene are known as
   A. alleles
   B. gametes
   C. genotypes
   D. heterozygotes

22. Mendel’s principle of segregation states that alternate forms of a gene separate during
   A. fertilization
   B. seed dispersal
   C. cross-pollination
   D. gamete formation

23. An organism is heterozygous for two pairs of genes. The number of different combinations of alleles that can form for these two genes in the organism’s gametes is
   A. 1
   B. 2
   C. 4
   D. 8
Use the following information to answer the next three questions.

Deaf-mutism is an autosomal recessive trait that is caused by two genes. Individuals who are homozygous recessive for either gene will have deaf-mutism. The two genes are designated as $D$ and $E$ in the diagram below.

**Partial Pedigree for Deaf-Mutism**

![Pedigree Diagram]

---from Huskey, 1998

24. A possible genotype of individual IV-3 is
   A. $ddEE$
   B. $ddEe$
   C. $DDee$
   D. $DdEe$

25. Individuals III-1 and III-2 are expecting their seventh child. What is the probability of this child having deaf-mutism?
   A. 0.00
   B. 0.25
   C. 0.50
   D. 0.75

**Numerical Response**

3. What is the probability of a couple that are heterozygous for both genes having a child with deaf-mutism?

   **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.)
Use the following information to answer the next three questions.

In the hypothetical pedigree below, shaded individuals have sickle cell anemia and are homozygous for the defective allele $Hb^S$. The normal allele is $Hb^A$. Carriers of the $Hb^S$ allele are not identified in the pedigree.

26. Individual III-1 has blood type A. His genotype could be

A. $I^A i \ Hb^A Hb^S$
B. $I^A I^A Hb^S Hb^S$
C. $I^A I^B Hb^A Hb^S$
D. $I^A I^A Hb^A Hb^A$

27. If individual II-1 has blood type A and individual II-2 has blood type B, which of the following genotypes would be possible for their third child, if they had one?

A. $I^A i \ Hb^A Hb^S$
B. $I^A I^A Hb^S Hb^S$
C. $I^B I^B Hb^A Hb^S$
D. $I^A I^B Hb^A Hb^A$

28. Which of the following rows indicates the relationship between the $I^A$ and $I^B$ alleles and the relationship between the $I^A$ and $i$ alleles for the blood type gene?

<table>
<thead>
<tr>
<th>Row</th>
<th>Relationship between $I^A$ and $I^B$</th>
<th>Relationship between $I^A$ and $i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>codominant</td>
<td>codominant</td>
</tr>
<tr>
<td>B.</td>
<td>codominant</td>
<td>dominant-recessive</td>
</tr>
<tr>
<td>C.</td>
<td>dominant-recessive</td>
<td>codominant</td>
</tr>
<tr>
<td>D.</td>
<td>dominant-recessive</td>
<td>dominant-recessive</td>
</tr>
</tbody>
</table>
Use the following information to answer the next three questions.

A dominant allele, \( X^E \), carried on the X chromosome causes the formation of faulty tooth enamel and causes either very thin or very hard enamel.

**Hypothetical Pedigree Showing the Incidence of Faulty Tooth Enamel**

29. The genotypes of individuals II-6 and III-7 are identified in row

<table>
<thead>
<tr>
<th>Row</th>
<th>II-6</th>
<th>III-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>( X^E X^E )</td>
<td>( X^E Y )</td>
</tr>
<tr>
<td>B.</td>
<td>( X^E X^e )</td>
<td>( X^e Y )</td>
</tr>
<tr>
<td>C.</td>
<td>( X^e X^e )</td>
<td>( X^E Y )</td>
</tr>
<tr>
<td>D.</td>
<td>( X^E X^E )</td>
<td>( X^e Y )</td>
</tr>
</tbody>
</table>

**Numerical Response**

4. A woman heterozygous for faulty tooth enamel marries a man with normal tooth enamel. What is the probability that their first child will be a boy with normal tooth enamel?

**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.)
30. The faulty tooth enamel trait will appear in all of the daughters but none of the sons if the children have a father with

A. normal tooth enamel and a mother with normal tooth enamel
B. normal tooth enamel and mother with faulty tooth enamel
C. faulty tooth enamel and a mother with normal tooth enamel
D. faulty tooth enamel and a mother with faulty tooth enamel

Use the following information to answer the next two questions.

<table>
<thead>
<tr>
<th>Cross-over Frequencies of Some Genes on Human Chromosome 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genes</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Diabetes mellitus (1) and ovarian cancer (2)</td>
</tr>
<tr>
<td>Diabetes mellitus (1) and Rhesus blood group (3)</td>
</tr>
<tr>
<td>Ragweed sensitivity (4) and Rhesus blood group (3)</td>
</tr>
<tr>
<td>Rhesus blood group (3) and ovarian cancer (2)</td>
</tr>
<tr>
<td>Ragweed sensitivity (4) and ovarian cancer (2)</td>
</tr>
</tbody>
</table>

Numerical Response
5. On human chromosome 6, the order of the genes numbered above is _____, _____, _____, and _____.

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

31. What is the approximate cross-over frequency between the diabetes mellitus gene and the ragweed sensitivity gene?

A. 1.5%
B. 10.5%
C. 15.0%
D. 22.5%
Desert-grassland whiptail lizards are all female, so they must reproduce by parthenogenesis. This is a type of reproduction in which females produce offspring from unfertilized eggs that have undergone chromosome doubling after meiosis. Although all whiptail lizards are females, they undergo courtship patterns similar to other types of lizards that have both sexes.

Sexual Behaviour in Parthenogenetic Lizards

——from Campbell, 1993

32. A correlation that can be made based on the data above is that

A. male-like behaviour is correlated with relatively large ovaries
B. female-like behaviour is correlated with relatively small ovaries
C. male-like behaviour is correlated with high blood levels of estrogen
D. female-like behaviour is correlated with high blood levels of estrogen

33. A similarity between lizard reproductive hormones and human reproductive hormones is that

A. after ovulation, ovaries decrease in size
B. before ovulation, ovaries increase in size
C. before ovulation, estrogen is secreted in decreasing amounts
D. after ovulation, progesterone is secreted in increasing amounts
34. According to the information on parthenogenetic lizards, the somatic cells of offspring produced from the whiptail lizard’s unfertilized eggs would have a chromosome number of

A. \( n \)
B. \( 2n \)
C. \( 4n \)
D. \( n + 2 \)

---

Use the following information to answer the next four questions.

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35. In the human ear, audible trumpeting sounds would be translated into nerve impulses in the

A. ossicles
B. oval window
C. organ of Corti
D. semicircular canals
36. In comparison with humans, elephants would be considered

A. *r*-selected, and they have a lower biotic potential than humans
B. *r*-selected, and they have a higher biotic potential than humans
C. *K*-selected, and they have a lower biotic potential than humans
D. *K*-selected, and they have a higher biotic potential than humans

37. Reproductive hormones function in a similar manner in elephants and in humans. The hormone change that stimulates ovulation every four years in female elephants is

A. an increase in LH levels
B. a decrease in FSH levels
C. a decrease in estrogen levels
D. an increase in progesterone levels

Use the following additional information to answer the next question.

Some female mammals, such as humans and elephants, exhibit a variety of differences in their reproductive cycles.

**Characteristics of Female Mammalian Reproductive Cycles**

1. The cycle is called an estrous cycle.
2. The cycle is called a menstrual cycle.
3. The endometrium is shed if no pregnancy occurs.
4. The endometrium is absorbed if no pregnancy occurs.
5. There are pronounced behavioural changes around ovulation.
6. There are some behavioural changes throughout the cycle.

**Numerical Response**

6. The three characteristics of most female elephants’ reproductive cycles but not of most female humans’ reproductive cycles are _____, _____, and _____.

(Record your three-digit answer in lowest to highest numerical order in the numerical-response section on the answer sheet.)
Use the following information to answer the next two questions.

**Fertilization**

Fertilization occurs when a sperm fuses with an egg to form a zygote. In this diagram of a zygote, the sperm and egg nuclei are just fusing. (One polar body is also visible.)

38. The event depicted above normally occurs in the

   A. ovary
   B. uterus
   C. vagina
   D. Fallopian tube

39. The zygote shown above is composed of

   A. one diploid cell
   B. two diploid cells
   C. one monoploid (haploid) cell
   D. one monoploid (haploid) and one diploid cell
Use the following information to answer the next two questions.

Fertilized Human Eggs
(Two Zygotes)

Eight-Cell Human Embryo

40. Which of the following statements best describes one of the diagrams above?

A. The two zygotes will form identical twins.
B. The two zygotes are about to undergo meiosis.
C. The cells of the eight-cell human embryo have differentiated.
D. The cells of the eight-cell human embryo contain identical DNA.

41. The process that occurs to form an eight-cell embryo stage from a zygote is

A. mitosis of diploid cells
B. mitosis of haploid cells
C. meiosis of diploid cells
D. meiosis of haploid cells
Use the following information to answer the next two questions.

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42. One piece of evidence that the researchers used to determine that the timber companies’ strategy was not working for all bears was that some of the feces contained

A. bark chips and cells with two X chromosomes
B. bark chips and cells with one Y chromosome
C. food particles consistent with the food provided and cells with two X chromosomes
D. food particles consistent with the food provided and cells with one Y chromosome

Use the following additional information to answer the next question.

Biologists have been able to map the large territory inhabited by the bear population by locating their feces. In order to use DNA found in feces to track bears, it is necessary to identify individual bears by the DNA found in their feces. One technique that is used to do this is DNA fingerprinting.

43. In DNA fingerprinting, gel electrophoresis is used to

A. cut DNA into fragments
B. separate fragments of DNA
C. match a gene with its function
D. pair homologous chromosomes
Use the following information to answer the next two questions.

Researchers analyzing spotted owl pellets found high levels of stress hormones in owls whose nests are within a quarter mile of logging areas. This information could be used to determine how large of a buffer zone is needed between the birds and the logging areas.

**Animal Stress Response Flowchart**

Due to copyright restrictions we are unable to post this information—copies of the exam are available for purchase at Learning Resource Centre.

Use the following additional information to answer the next question.

**Hormones Involved in an Owl’s Stress Response That Could be Measured by Scientists**

1. Cortisol
2. Aldosterone
3. ACTH
4. Epinephrine

**Numerical Response**

7. Match the hormones, as numbered above, to the letters A, B, C, and D in the flowchart above.

   Hormone Number:   __   __   __   __
   Flowchart Letter:  A  B  C  D

   (Record your four-digit answer in the numerical-response section on the answer sheet.)
44. In the owls, short-term response to stress occurs faster than prolonged response to stress because the
   A. blood from the adrenal medulla travels faster than does the blood from the adrenal cortex
   B. adrenal medulla responds to nervous stimulation, which is faster than hormonal stimulation
   C. adrenal medulla is controlled by the hypothalamus whereas the adrenal cortex is controlled by the pituitary
   D. hormone from the adrenal medulla acts on cells more quickly than the hormones from the adrenal cortex

Use the following information to answer the next three questions.

Due to copyright restrictions we are unable to post this information—copies of the exam are available for purchase at Learning Resource Centre.

45. The hissing behaviour of the baby owls is an example of
   A. mimicry
   B. mutualism
   C. camouflage
   D. commensalism

A Burrowing Owl

Due to copyright restrictions we are unable to post this information—copies of the exam are available for purchase at Learning Resource Centre.
Numerical Response

8. If the decline of the burrowing owl population continued at the same rate, how many breeding pairs would there have been in 1998?

Answer: __________ breeding pairs

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

Use the following additional information to answer the next question.

The burrowing owl habitat is open prairie grass. The owls live in ground squirrel holes that have been enlarged by badgers. The young owls are cared for by both parents who feed them a diet consisting of mice, moles, and insects. Other prairie predators such as the rattlesnake and kestrel (sparrow hawk) also rely upon these same food sources.

46. The relationship between the kestrel and the burrowing owl and the relationship between the burrowing owl and badger are given in row

<table>
<thead>
<tr>
<th>Row</th>
<th>Kestrel/Burrowing Owl</th>
<th>Burrowing Owl/Badger</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>predator–prey</td>
<td>mutualism</td>
</tr>
<tr>
<td>B.</td>
<td>predator–prey</td>
<td>commensalism</td>
</tr>
<tr>
<td>C.</td>
<td>interspecific competition</td>
<td>mutualism</td>
</tr>
<tr>
<td>D.</td>
<td>interspecific competition</td>
<td>commensalism</td>
</tr>
</tbody>
</table>
The population of a colony of honey bees (*Apis mellifera*) in Alberta varies seasonally as illustrated in the following graph.

47. The portion of the graph for April **most likely** indicates the effect of

A. an increase in parasitism
B. a decrease in competition
C. a decrease in limiting factors
D. an increase in environmental resistance

48. The relationship between bees and mites is called

A. parasitism
B. commensalism
C. interspecific competition
D. intraspecific competition
Although doctors were astonished, relatives were not surprised when Benjy Stacy was born with skin the colour of a bruised plum. Two days of medical tests to rule out possible heart and lung disease revealed no cause for the newborn’s dark blue skin. Not until Benjy’s grandmother asked the puzzled doctors if they had ever heard of the blue Fugates of Troublesome Creek was the mystery solved. When baby Benjy inherited his mother’s red hair and his father’s lankiness, he also received his great-great-great-grandfather Martin Fugate’s blue skin.

In 1820, a French orphan named Martin Fugate settled on the banks of Troublesome Creek. He and his red-headed American bride Elizabeth had seven children, four of which were reported to be blue-skinned. Isolated in the hills of eastern Kentucky, the family multiplied. Intermarriages between “blue Fugates” were common. Over time, the inherited blue trait began to disappear as the arrival of railways and roads allowed family members to marry outside their communities. Six generations after Martin Fugate first settled in Troublesome Creek, baby Benjy was born.

Based on Benjy’s grandmother’s account and further testing, doctors concluded that the newborn carried one copy of a mutated gene for methemoglobinemia. Hereditary methemoglobinemia is a rare autosomal recessive blood disorder. Blue people have an absence of the enzyme diaphorase in their red blood cells. In a normal individual, hemoglobin, the blood’s red, oxygen-carrying molecule, is slowly converted to an non-functional blue form called methemoglobin. Diaphorase then converts methemoglobin back to hemoglobin. The absence of diaphorase in affected individuals is caused by a mutation in the enzyme’s structural gene. This causes the accumulation of blue methemoglobin, which replaces the red hemoglobin responsible for pink skin in most Caucasians.

—from Trost, 1982

**Written Response – 15%**

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

1. a. Explain how a gene mutation could alter the diaphorase enzyme’s amino acid sequence. (2 marks)
In one account of the Fugate family’s pedigree from 1750 to 1889, six of the 55 individuals expressed the blue phenotype as adults.

b. Determine the frequency of the recessive allele for the Fugate family during this time. Show your work. **(2 marks)**

c. Predict the theoretical percentage of individuals in the Fugate family that were heterozygotes during this time. Show your work. **(2 marks)**

d. Explain why the frequency of the blue skin phenotype was higher in the Fugate family than in the general American population. **(1 mark)**

e. Identify two ways in which the population, which consisted of six generations of the Fugate family, did not meet the conditions for Hardy–Weinberg equilibrium. **(2 marks)**
f. Although he was very blue at birth, within his first few weeks, Benjy’s skin colour changed to normal with no treatment required. At the age of seven, other than purplish blue lips when he was cold or angry, Benjy’s colouration was normal.

   i. What is Benjy’s genotype? (1 mark)

   ii. Give a possible explanation for the change in Benjy’s phenotype over time. (1 mark)

   iii. Individuals with hereditary methemoglobinemia can be treated easily with methylene blue pills. Methylene blue acts as an “electron donor” converting methemoglobin to hemoglobin, which results in pink skin colouration. Explain why treated blue people can still produce offspring with hereditary methemoglobinemia. (1 mark)
Use the following information to answer the next question.

Due to copyright restrictions we are unable to post this information—copies of the exam are available for purchase at Learning Resource Centre.

**Written Response – 15%**

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

2. Write a unified response addressing the following aspects of fetal development and development in early childhood.

   - **Sketch** a diagram of the fetus and its environment at approximately three months development and **label** four structures that support the fetus in this environment. **Describe** how the environment in the uterus and structures associated with the fetus support the fetus during this stage of development.
• **Describe** the pathway for sensory interpretation in a fetus or newborn. Start from a **specific** stimulus to the part of the CNS that is stimulated in order for interpretation to occur.

• **Identify** and **describe** two technologies and/or government policies that might result in stimulation of appropriate neural development in children. **Explain** how each of these would affect neural development in early childhood.

  Three-Month-Old Fetus and Associated Structures

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You have now completed the examination.
If you have time, you may wish to check your answers.
References


NR6


NR7


NR8


Credits


NR3


WR1 Cathy Trost. From “The Blue People of Troublesome Creek” as found on http://wsrv.clas.virginia.edu/~rjh9u/blkysc82.html. Adapted and reprinted with permission from Cathy Trost.

Diagram by Robert J. Huskey. From www.people.virginia.edu/~rjh9u/diaenz.html. Adapted and reprinted with permission from Robert J. Huskey, University of Virginia.
## Biology Data

### Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_p$</td>
<td>population density</td>
<td>$\varnothing$</td>
<td>male</td>
</tr>
<tr>
<td>$N$</td>
<td>numbers of individuals in a population</td>
<td>$\varnothing$</td>
<td>female</td>
</tr>
<tr>
<td>$A$</td>
<td>area, space, or volume occupied by a population</td>
<td>$n$</td>
<td>chromosome number</td>
</tr>
<tr>
<td>$t$</td>
<td>time</td>
<td>$B, b$</td>
<td>alleles; upper case is dominant, lower case is recessive</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>change</td>
<td>$I^A, I^B, i$</td>
<td>alleles, human blood type (ABO)</td>
</tr>
<tr>
<td>$r$</td>
<td>biotic potential OR maximum per capita population growth rate</td>
<td>$P$</td>
<td>parent generation</td>
</tr>
<tr>
<td>$K$</td>
<td>carrying capacity</td>
<td>$F_1, F_2$</td>
<td>first, second filial (generation)</td>
</tr>
<tr>
<td>$\frac{\Delta N}{\Delta t}$</td>
<td>a change in population size during time interval</td>
<td>$p$</td>
<td>frequency of dominant allele</td>
</tr>
<tr>
<td>$&gt;$</td>
<td>greater than, dominant over</td>
<td>$q$</td>
<td>frequency of recessive allele</td>
</tr>
<tr>
<td>$&lt;$</td>
<td>less than, recessive to</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Equations

<table>
<thead>
<tr>
<th>Subject</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardy–Weinberg principle</td>
<td>$p^2 + 2pq + q^2 = 1$</td>
</tr>
<tr>
<td>Population density</td>
<td>$D_p = \frac{N}{A}$</td>
</tr>
<tr>
<td>Change in population size</td>
<td>$\Delta N = \text{(factors that increase pop.)} - \text{(factors that decrease pop.)}$</td>
</tr>
<tr>
<td>Per capita growth rate</td>
<td>$\text{cgr} = \frac{\Delta N}{N}$</td>
</tr>
<tr>
<td>(time will be determined by the question)</td>
<td></td>
</tr>
<tr>
<td>Growth rate</td>
<td>$\frac{\Delta N}{\Delta t} = rN$</td>
</tr>
<tr>
<td></td>
<td>$\frac{\Delta N}{\Delta t} = rN \frac{(K - N)}{K}$</td>
</tr>
</tbody>
</table>
### Abbreviations for Some Hormones

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenocorticotropin hormone</td>
<td>ACTH</td>
</tr>
<tr>
<td>Antidiuretic hormone</td>
<td>ADH</td>
</tr>
<tr>
<td>Follicle stimulating hormone</td>
<td>FSH</td>
</tr>
<tr>
<td>Human chorionic gonadotropin</td>
<td>HCG</td>
</tr>
<tr>
<td>Luteinizing hormone</td>
<td>LH (formerly ICSH in males)</td>
</tr>
<tr>
<td>Parathyroid hormone</td>
<td>PTH</td>
</tr>
<tr>
<td>Prolactin</td>
<td>PRL</td>
</tr>
<tr>
<td>Somatotropin (human growth hormone or growth hormone)</td>
<td>STH (HGH or GH)</td>
</tr>
<tr>
<td>Thyroid stimulating hormone</td>
<td>TSH</td>
</tr>
</tbody>
</table>

### Pedigree Symbols

- **Male**
- **Female**
- **Mating**
- **Mating between close relatives**
- **Roman numerals** symbolize generations
- **Arabic numbers** symbolize individuals within a given generation
- **Birth order, within each group of offspring, is drawn left to right, oldest to youngest**

- **Identical twins**
- **Non-identical twins**
- **Affected individuals**
- **Known heterozygotes for autosomal recessive**
- **Known carrier of X-linked recessive**
- **Deceased individuals**
- **Sex unknown**
### Messenger RNA Codons and Their Corresponding Amino Acids

<table>
<thead>
<tr>
<th>First Base</th>
<th>Second Base</th>
<th>Third Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>UUU</td>
<td>phenylalanine</td>
</tr>
<tr>
<td></td>
<td>UUC</td>
<td>phenylalanine</td>
</tr>
<tr>
<td></td>
<td>UUA</td>
<td>leucine</td>
</tr>
<tr>
<td></td>
<td>UUG</td>
<td>leucine</td>
</tr>
<tr>
<td></td>
<td>UCU</td>
<td>serine</td>
</tr>
<tr>
<td></td>
<td>UCC</td>
<td>serine</td>
</tr>
<tr>
<td></td>
<td>UCA</td>
<td>serine</td>
</tr>
<tr>
<td></td>
<td>UCG</td>
<td>serine</td>
</tr>
<tr>
<td>C</td>
<td>CUU</td>
<td>leucine</td>
</tr>
<tr>
<td></td>
<td>CUC</td>
<td>leucine</td>
</tr>
<tr>
<td></td>
<td>CUA</td>
<td>leucine</td>
</tr>
<tr>
<td></td>
<td>CUG</td>
<td>leucine</td>
</tr>
<tr>
<td>A</td>
<td>AUU</td>
<td>isoleucine</td>
</tr>
<tr>
<td></td>
<td>AUC</td>
<td>isoleucine</td>
</tr>
<tr>
<td></td>
<td>AUG</td>
<td>methionine*</td>
</tr>
<tr>
<td>G</td>
<td>GUU</td>
<td>valine</td>
</tr>
<tr>
<td></td>
<td>GUC</td>
<td>valine</td>
</tr>
<tr>
<td></td>
<td>GUA</td>
<td>valine</td>
</tr>
<tr>
<td></td>
<td>GUG</td>
<td>valine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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

<table>
<thead>
<tr>
<th>Nitrogen Base</th>
<th>Classification</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenine</td>
<td>Purine</td>
<td>A</td>
</tr>
<tr>
<td>Guanine</td>
<td>Purine</td>
<td>G</td>
</tr>
<tr>
<td>Cytosine</td>
<td>Pyrimidine</td>
<td>C</td>
</tr>
<tr>
<td>Thymine</td>
<td>Pyrimidine</td>
<td>T</td>
</tr>
<tr>
<td>Uracil</td>
<td>Pyrimidine</td>
<td>U</td>
</tr>
</tbody>
</table>
No marks will be given for work done on this page.
No marks will be given for work done on this page.
Biology 30
Diploma Examination
June 2001

Multiple–Choice Key,
Numerical–Response Key,
and
Sample Answers to
Written–Response Questions
Biology June 2001 Diploma Examination
Multiple Choice and Numerical Response Keys

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

1. 2143
2. 2467
3. 0.44
4. 0.25
5. 2341 or 1432
6. 145
7. 3214
8. 512
Although doctors were astonished, relatives were not surprised when Benjy Stacy was born with skin the colour of a bruised plum. Two days of medical tests to rule out possible heart and lung disease revealed no cause for the newborn’s dark blue skin. Not until Benjy’s grandmother asked the puzzled doctors if they had ever heard of the blue Fugates of Troublesome Creek was the mystery solved. When baby Benjy inherited his mother’s red hair and his father’s lankiness, he also received his great-great-great-grandfather Martin Fugate’s blue skin.

In 1820, a French orphan named Martin Fugate settled on the banks of Troublesome Creek. He and his red-headed American bride Elizabeth had seven children, four of which were reported to be blue-skinned. Isolated in the hills of eastern Kentucky, the family multiplied. Intermarriages between “blue Fugates” were common. Over time, the inherited blue trait began to disappear as the arrival of railways and roads allowed family members to marry outside their communities. Six generations after Martin Fugate first settled in Troublesome Creek, baby Benjy was born.

Based on Benjy’s grandmother’s account and further testing, doctors concluded that the newborn carried one copy of a mutated gene for methemoglobinemia. Hereditary methemoglobinemia is a rare autosomal recessive blood disorder. Blue people have an absence of the enzyme diaphorase in their red blood cells. In a normal individual, hemoglobin, the blood’s red, oxygen-carrying molecule, is slowly converted to an non-functional blue form called methemoglobin. Diaphorase then converts methemoglobin back to hemoglobin. The absence of diaphorase in affected individuals is caused by a mutation in the enzyme’s structural gene. This causes the accumulation of blue methemoglobin, which replaces the red hemoglobin responsible for pink skin in most Caucasians.

—from Trost, 1982

**Written Response – 15%**

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

1. a. Explain how a gene mutation could alter the diaphorase enzyme’s amino acid sequence. (2 marks)

   A gene mutation alters the nitrogen-base sequence of the gene’s DNA. (1 mark)

   This change in the sequence results in an altered mRNA nitrogen-base sequence that, in turn, can alter the amino acids in the diaphorase enzyme. (1 mark)
Use the following additional information to answer the next three parts of the question.

In one account of the Fugate family’s pedigree from 1750 to 1889, six of the 55 individuals expressed the blue phenotype as adults.

b. Determine the frequency of the recessive allele for the Fugate family during this time. Show your work. (2 marks)

\[ q^2 = \frac{6}{55} = 0.11 \] (1 mark)

\[ q = 0.33 \]

The frequency of the recessive allele is 0.33. (1 mark)

c. Predict the theoretical percentage of individuals in the Fugate family that were heterozygotes during this time. Show your work. (2 marks)

\[ p + q = 1 \]
\[ 1 - 0.33 = p \]
\[ p = 0.67 \]
\[ 2pq = 2(0.33)(0.67) = 0.44 \] (1 mark)

Theoretically, 44% of the individuals were heterozygous for the allele. (1 mark)

d. Explain why the frequency of the blue skin phenotype was higher in the Fugate family than in the general American population. (1 mark)

The mutation first occurred in an individual in the Fugate family; therefore, more members of this family have the allele than do the general population.

or

Intemarriage within the Fugate family increased the probability of two carriers mating and producing blue offspring.

or

Because the Fugate family lived in an isolated area, the likelihood of carriers mating and producing blue offspring increased.
e. Identify two ways in which the population, which consisted of six generations of the Fugate family, did not meet the conditions for Hardy–Weinberg equilibrium. (2 marks)

Any two of the following:
- The population was small, and a large population is required to meet the conditions for Hardy–Weinberg equilibrium.
- There was non-random mating rather than the random mating required for Hardy–Weinberg equilibrium.
- Mutation occurred to produce the defective diaphorase, and Hardy–Weinberg equilibrium requires no mutation.
- Emigration or immigration from the population occurred, and migration does not occur in populations that satisfy Hardy–Weinberg equilibrium.

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

![Graph showing RBC NADH Diaphorase Activity over time for normal control, Heterozygotes (Bb), and Blue people (bb).](image)

The data above were obtained by extracting red blood cells from three different groups of individuals. The red blood cells were then evaluated for their ability to convert methemoglobin to hemoglobin.

—from Huskey, 1996

f. Although he was very blue at birth, within his first few weeks, Benjy’s skin colour changed to normal with no treatment required. At the age of seven, other than purplish blue lips when he was cold or angry, Benjy’s colouration was normal.

i. What is Benjy’s genotype? (1 mark)

*Bb (heterozygous)*
ii. Give a possible explanation for the change in Benjy’s phenotype over time. (1 mark)

- Benjy produced some normal diaphorase and, over time, was able to convert enough methemoglobin into hemoglobin to express a normal skin colour.

  or

- Fetal hemoglobin is different than adult hemoglobin. Therefore, the expression of Benjy’s phenotype may have changed shortly after birth.

  or

Any other reasonable explanation.

iii. Individuals with hereditary methemoglobinemia can be treated easily with methylene blue pills. Methylene blue acts as an “electron donor” converting methemoglobin to hemoglobin, which results in pink skin colouration. Explain why treated blue people can still produce offspring with hereditary methemoglobinemia. (1 mark)

*Treatment does not change the alleles present in the germ cells of the individuals, which can still be passed on to future generations.*
2. Write a unified response addressing the following aspects of fetal development and development in early childhood.
Sample Answers

- **Sketch** a diagram of the fetus and its environment at approximately three months development and **label** four structures that support the fetus in this environment. **Describe** how the environment in the uterus and structures associated with the fetus support the fetus during this stage of development.

---

The amniotic fluid surrounding the fetus functions to protect the fetus from physical trauma. The amniotic sac that holds the amniotic fluid provides a protective barrier for the fetus preventing the entrance of harmful bacteria, viruses, and other harmful pathogens and chemicals into the amniotic fluid that would eventually affect the fetus. It also helps to regulate temperature for the fetus. The placenta acts as a barrier between the fetal blood supply and the maternal blood supply. It is the site of nutrient, gas, and waste exchange between the fetal circulation and maternal circulation. Nutrients and oxygen diffuse into the fetal blood while carbon dioxide and wastes diffuse into maternal blood. The placenta also produces hormones. HCG stimulates the corpus luteum to produce estrogen and progesterone to maintain pregnancy in the first trimester. The placenta also acts as a barrier to some pathogens that may be in the mother’s body. The umbilical cord contains blood vessels that transport blood between the placenta and the fetus.
• **Describe** the pathway for sensory interpretation in a fetus or newborn. Start from a **specific** stimulus to the part of the CNS that is stimulated in order for interpretation to occur.

*A mother’s voice produces sound waves. Sound waves are converted to fluid waves in the ear of her fetus within her uterus. These fluid waves stimulate hair cells in the organ of Corti located within the cochlea. This creates action potentials in sensory neurons in the auditory nerve. The sensory neurons synapse with interneurons. Eventually stimulation of interneurons occurs in the temporal lobe of the brain where auditory information is interpreted.*

*or*

*Any other specific stimuli pathway to the CNS could be described.*

• **Identify** and **describe** two technologies and/or government policies that might result in stimulation of appropriate neural development in children. **Explain** how each of these would affect neural development in early childhood.

*One technology that could stimulate appropriate neural development in infants is the use of colourful mobiles and learning centers. These would cause sensory receptors to be stimulated and eventually stimulate neurons in the brain. The stimulation of neurons creates appropriate synapses and helps neurons to develop.*

*A government policy that would also have a positive influence on fetal development would be the formation of a childhood development specialist team made up of early childhood educators, public health nurses, social workers, child psychologists, and early childhood movement specialists. This specialist team would be available to assess individual home situations, provide information seminars in prenatal classes and to parent groups, and offer assistance in setting up a rearing environment that provides an optimal amount of stimulation for the infant. Appropriate stimulation will develop neuron connections, increase the size of the brain and help develop appropriate social responses.*

*Other technologies or government policies that could be described are:*

• any technology that stimulates the senses and therefore increases neural stimulation
• any government policy that would help increase appropriate stimulation of a child or appropriate interaction of a child with a significant adult
• technologies to investigate genetic causes of abnormal brain development and/or to correct these
• government policies or technologies that would protect the fetal environment from conditions that might affect neural development*
<table>
<thead>
<tr>
<th>Score</th>
<th>Scoring Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><strong>Excellent</strong></td>
</tr>
<tr>
<td></td>
<td>- sketches the fetal environment accurately and correctly labels four parts&lt;br&gt;- clearly describes in detail how the fetal environment supports the fetus at three months of development&lt;br&gt;- clearly describes the pathway for sensory interpretation in a fetus or newborn from a specific stimulus</td>
</tr>
<tr>
<td>4</td>
<td><strong>Proficient</strong></td>
</tr>
<tr>
<td></td>
<td>- sketches the fetal environment accurately and correctly labels three parts&lt;br&gt;- describes how the fetal environment supports the fetus&lt;br&gt;- describes the pathway for sensory interpretation from a specific stimulus</td>
</tr>
<tr>
<td>3</td>
<td><strong>Satisfactory</strong></td>
</tr>
<tr>
<td></td>
<td>- sketches the fetal environment and correctly labels two parts&lt;br&gt;- partially describes how the fetal environment supports the fetus&lt;br&gt;- partially describes a pathway for sensory interpretation</td>
</tr>
<tr>
<td>2</td>
<td><strong>Limited</strong></td>
</tr>
<tr>
<td></td>
<td>- attempts a sketch of the fetal environment and correctly labels one part or an accurate sketch is drawn&lt;br&gt;- describes at least one supporting structure in the fetal environment&lt;br&gt;- identifies one step in a pathway for sensory interpretation</td>
</tr>
<tr>
<td>1</td>
<td><strong>Poor</strong></td>
</tr>
<tr>
<td></td>
<td>- only one of the scoring bullets is addressed at a 2 or 3 level</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Score</th>
<th>Scoring Criteria</th>
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</thead>
<tbody>
<tr>
<td><strong>5</strong> Excellent</td>
<td>• identifies and describes two relevant technologies or government policies that would stimulate neural development&lt;br&gt;• clearly explains how each technology or government policy would affect neural development</td>
</tr>
<tr>
<td><strong>4</strong> Proficient</td>
<td>• identifies two relevant technologies or government policies and describes one or identifies and partially describes two relevant technologies or government policies&lt;br&gt;• explains how one technology or government policy would affect neural development and partially explains the other</td>
</tr>
<tr>
<td><strong>3</strong> Satisfactory</td>
<td>• identifies one relevant technology or government policy and partially describes the other or identifies or partially describes two&lt;br&gt;• explains how one technology or government policy would affect neural development or partially explains both</td>
</tr>
<tr>
<td><strong>2</strong> Limited</td>
<td>• identifies one relevant technology or government policy or partially describes one&lt;br&gt;• partially explains how one technology or government policy would affect neural development</td>
</tr>
<tr>
<td><strong>1</strong> Poor</td>
<td>• addresses one of the two scoring bullets at a 2 level</td>
</tr>
</tbody>
</table>

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