Provincial Report

Biology 30 Grade 12 Diploma Examination

September 1984

Student Evaluation

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PREFACE

This report presents the provincial results of the Biology 30 Diploma Examination administered on June 25, 1984. During this second administration, the Biology 30 Diploma Examination was written by 7894 students. This report provides information about the examination development process, the examination itself, and the examination results.

ACKNOWLEDGMENTS

This second administration of the Biology 30 Diploma Examination was successful due to the concerted effort of all involved. Success would have been impossible without substantial contributions from many people, particularly the administrators, teachers, and students, who extended their full co-operation.

The technical expertise and advice received from the Examination Review Committee regarding design, development, and reporting have been particularly valuable in the implementation of this diploma examination. This Committee has representation from:

The Alberta Teachers' Association
The Conference of Alberta School Superintendents
The Universities Co-ordinating Council
The Public Colleges of Alberta
Alberta Education

The contribution of this group is gratefully acknowledged.

Lloyd E. Symyrozum
Director
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CHAPTER 1

Grade 12 Diploma Examinations Program

Introduction

All Grade 12 students in Alberta are now required to write at least ONE diploma examination to receive a high school diploma. Mature students may receive credits for a Grade 12 course by writing the appropriate diploma examination. They are not required to be registered in the course. The Grade 12 Diploma Examinations Program, which is an integral part of the high school diploma requirements, is intended to develop and maintain excellence in educational standards through certification of academic achievement.

The Diploma Examinations Program consists of course-specific examinations that are based on the prescribed *Program of Studies for Senior High Schools* for the following Grade 12 courses: English 30, English 33, Social Studies 30, Mathematics 30, Biology 30, Chemistry 30, and Physics 30.

Alberta Education issues two distinct high school diplomas: the General High School Diploma and the Advanced High School Diploma.

General High School Diploma

To earn a General High School Diploma, a student must obtain course credit in either English 30 or English 33, and obtain 100 credits distributed over courses as specified in the *Junior-Senior High School Handbook*. Some students who are working toward the general diploma may wish to obtain credits in other diploma examination courses (i.e., Social Studies 30, Mathematics 30, Biology 30, Chemistry 30, and Physics 30). To obtain credits in these courses, a student must also write the appropriate diploma examination regardless of the type of diploma he wishes to receive.

Advanced High School Diploma

The Advanced High School Diploma represents achievement in an academic program that includes language arts (English), social studies, mathematics, and science. To earn an Advanced High School Diploma, a student must satisfy the current course and credit requirements for a General High School Diploma, and obtain course credits in English 30, Social Studies 30, Mathematics 30, and ONE of Biology 30, Chemistry 30, or Physics 30.

Awarding of Course Credits

Grade 10 and Grade 11 Courses. To obtain credits in Grade 10 (10-level) and Grade 11 (20-level) courses, a student must earn a final mark of 40% or better. A student who has achieved a mark of 50% or higher in a given course is eligible to take the next or higher-rank high school course in that sequence.

Grade 12 Courses. To obtain credit in a Grade 12 (30-level) course, a student must earn a final mark of 50% or better. To obtain credit in a Grade 12 diploma examination course, a student must write the appropriate diploma examination and attain a final blended mark of 50% or better. The final blended mark is made up of 50% of the mark awarded by the school and 50% of the diploma examination mark. For example, a student taking Biology 30 might have a mark of 45% from his school and a mark of 57% on the diploma examination. This student would earn credits for Biology 30 because his final mark would be 51%, which is the average of the school and examination marks. For mature students who do not have a school mark or who have a school mark lower than the examination mark, the examination mark is the final mark.

Transitional Provisions

During the 1983/84 school year, Alberta Education will recognize all course credits earned prior to September 1, 1983, for the purpose of awarding the General High School Diploma.

A student who has completed partial requirements for the Advanced High School Diploma prior to September 1, 1983, and who is enrolled in Grade 12 courses during the 1983/84 school year, may apply any of the previously completed required diploma examination subjects toward a diploma provided that the student has earned a final course mark of 50% or better in each subject.

Award of Excellence

When candidates for an Advanced High School Diploma obtain a final average of 80% or higher on the four required diploma examination courses with not less than 65% in any one of these four required courses, they receive an Award of Excellence. This Award of Excellence is noted on the student's Advanced High School Diploma.

When a student writes two or three of the diploma examinations in Biology 30, Chemistry 30, and Physics 30, the highest of these final course marks is used for diploma purposes and in the calculation of the average for the Award of Excellence.

CHAPTER 2

Description of the Examination

This chapter outlines the procedures that were followed during test development and describes the structure and content of the examination. Sample questions from the June 1984 examination are included.

Examination Development

There were three stages in the development of the June 1984 Biology 30 Diploma Examination: preparation of curriculum specifications, development of questions, and selection of questions for the final copy.

1. Curriculum Specifications

The Curriculum Branch of Alberta Education prepared curriculum specifications based on the topical outline of the Biology 30 core described in the *Program of Studies for Senior High Schools*. In these specifications, weightings were assigned to each major content area and to specific topics outlined in the *Program of Studies*. These weightings were based on the emphasis that each topic was to receive in the Biology 30 program. The curriculum specifications were distributed to all school jurisdictions in the province.

Topic statements upon which specific questions were based, along with sample questions for each topic, are given in this chapter.

2. Development of Questions

Committees composed of teachers and Student Evaluation Branch personnel constructed questions to reflect the content statements listed in the curriculum specifications. The questions were field-tested, and revisions were made on the basis of teacher recommendations and the field-test results.

3. Final Copy

A test development specialist, assisted by a committee of classroom teachers, built the examination from suitable questions. These committees selected questions from various content areas so that each area received the emphasis recommended in the curriculum specifications. An Examination Review Committee checked the proposed examination for content validity, accuracy, and technical merit, and further changes were made in accordance with their recommendations.

Examination Description

On the Biology 30 Diploma Examination, each content area received the following emphasis:

<u>Content Area</u>	<u>Emphasis in % of the Total Examination Mark</u>
Physical Properties of Cells	13
Nutrition	22
Circulation	11
Gas Exchange	8
Cellular Respiration	6
Excretion	8
Metabolic Controls	25
Human Reproduction	7

To the extent that paper-and-pencil testing permitted, the Biology 30 Diploma Examination assessed the application of the scientific process skills of interpreting data, inferring, predicting, processing data, hypothesizing, and controlling variables. The questions that are readily identified with specific process skills are listed below.

<u>Process Skill</u>	<u>Multiple-Choice Question</u>	<u>Written-Response Question</u>
Interpreting Data	4,6,14,15,18,23,26,34,35,43, 61,65,71,78	2
Inferring	5,24,27,57,58,60,67,77,78	2,4,7,8
Predicting	1,2,7,17,18,21,26,34,59,61, 71,72,79	1,5,7
Processing Data	1,2,7,18,34,43,61,65,71	--
Hypothesizing	4,59,60,62,80	--
Controlling Variables	57,60,65,71,72	1,3,4,5,8

Understandably, the experience gained by direct, hands-on activities are difficult to measure outside a laboratory situation and should therefore be reflected in student performance as evaluated by the teacher.

Subject matter in the attitudinal and psychomotor components of the program was also excluded from the diploma examination.

The time allotted for writing the Biology 30 Diploma Examination was two and one-half hours. The examination consisted of both multiple-choice questions (worth 80% of the total examination mark) and written-response questions (worth 20% of the total examination mark). There were 80 multiple-choice questions worth one mark each and eight written-response questions worth a total of 20 marks.

The classification of examination questions according to content area and cognitive level is presented in Table 1.

Table 1

June 1984 Biology 30 Diploma Examination Blueprint

COGNITIVE LEVEL SUBJECT MATTER	KNOWLEDGE	APPLICATION AND UNDERSTANDING	HIGHER MENTAL ACTIVITIES	TOTALS
1. Physical Properties of Cells	19,25,51	20,21,22,23,24 [WR 1]	18,26	10 (3)
2. Nutrition	3,7,8,9, 10,11,12, 13,16	1,2,4,6,17 [WR 2,4]	5,14,15	17 (5)
3. Circulation	33	27,28,29,30,31, 32,35,36 [WR 3]		9 (2)
4. Gas Exchange	38,39,40, 41	34,37,42	43	8
5. Cellular Respiration	45,46,48	44,47,49		6
6. Excretion	50,54,55	52,53,56	[WR 5]	6 (2)
7. Metabolic Controls	69,70	57,58,62,63,64, 65,66,67,68,73 [WR 6,7,8b]	59,60,61,71, 72 [WR 8a]	17 (8)
8. Human Reproduction		74,75,76,77,78, 79,80		7
TOTALS	25	60	15	100

Values for written-response questions [WR] are indicated by ().

Explanation of Blueprint Cognitive Levels

1. Knowledge

Knowledge is defined as including those behaviors and test situations that emphasize the remembering, either by recognition or recall, of ideas, material, or phenomena. Incorporated at this level is knowledge of terminology, specific facts (dates, events, persons, etc.), conventions, classifications and categories, methods of inquiry, principles and generalizations, and theories and structures.

2. Application and Understanding

Application requires the student to apply an appropriate abstraction (theory, principle, idea, method) to a new situation.

Understanding refers to responses that represent a comprehension of the literal message contained in a communication. This means that the student is able to translate, interpret, or extrapolate. Translation refers to the ability to put a communication into another language. Interpretation involves the reordering of ideas (inferences, generalizations, or summaries). Extrapolation includes estimating or predicting based on an understanding of trends or tendencies.

3. Higher Mental Activities

Included in higher mental activities are the processes of analysis, synthesis, and evaluation. Analysis involves the ability to recognize unstated assumptions, to distinguish facts from hypotheses, to distinguish a conclusion from statements that support it, to recognize which facts or assumptions are essential to a main thesis or to the argument in support of that thesis, to distinguish cause-effect relationships from other sequential relationships, and to recognize the point of view of a writer.

Synthesis involves the production of a unique communication, the ability to propose ways of testing a hypothesis, the ability to design an experiment, the ability to formulate and modify a hypothesis, and the ability to make generalizations.

Evaluation is defined as the making of judgments about the value of ideas, solutions, and methods. It involves the use of criteria as well as standards for appraising the extent to which details are accurate, effective, economical, or satisfying. Evaluation involves the ability to apply given criteria to judgments of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.

The cognitive classification of examination questions may depend on the manner in which the content has been covered in the classroom. A question that is an application question for one class may be a knowledge question for another class.

Questions requiring knowledge and skill in the processes of science were included throughout the examination and are not associated with any specific topic or cognitive level.

Description of Subject Matter Areas and Sample Multiple-Choice Questions

The topics that were tested within each content area are listed and sample questions from the examination are provided. The correct response for each question is identified with an asterisk, and the percentage of students selecting each response is given.

1. Physical Properties of Cells

Cellular processes are not only fundamental to all life forms, but are also considered to be an essential unit in Biology 30. If the students cannot understand and apply the basic concepts taught in this unit, then they will not be able to build on this knowledge in subsequent units. The specific topic statements covered by the examination were:

- cells exhibit complex structure and function
- living organisms carry out chemical activities
- substances necessary for life are transported by physical and chemical processes

In the following example the students are required to understand the role played by buffer systems as homeostatic mechanisms.

Question 20:

All buffer systems are designed to maintain

Student Responses

5.2%	A. basic pH
2.7%	B. acidic pH
19.9%	C. neutral pH
72.1%	*D. constant pH
0.0%	no response

2. Nutrition

The June 1984 diploma examination reflected the transitional nature of the curriculum in that both autotrophic and heterotrophic nutrition from topics in the 1975 curriculum were covered.

The questions on autotrophism were selected from the autotrophic nutrition subtopic.

In the following example the students are required to interpret data from a graph and make predictions regarding this data.

Question 7:

Use the following information to answer question 7.

The most accurate conclusion one can draw from the graph is that photosynthesis

Student Responses

2.2%	A.	is not affected by low light intensity
89.5%	*B.	is greatest when carbon dioxide and light intensity are greatest
6.7%	C.	is least when light intensity is low and carbon dioxide content is high
1.5%	D.	is greatest when light intensity is low and carbon dioxide content is low
0.1%		no response

The questions on heterotropism focused primarily on human nutrition. The specific topic statements covered by the examination were:

- digestion includes the physical and chemical breakdown of ingested macromolecules, preparing them for absorption
- unusable substances are stored, then removed from the body
- environmental toxins may be retained by body tissue

In the following example the students are required to interpret data and make predictions regarding this data.

Question 26:

Use the following information to answer question 26.

Each test tube contains 1 mL of saliva and 5 mL of starch solution at the concentrations indicated.

Concentration of starch solution is indicated in percentages.

Which of the experimental designs would be most appropriate to test the effect of pH on the activity of amylase found in saliva?

Student Responses

61.6%	*A. I
16.0%	B. II
9.9%	C. III
12.5%	D. IV
0.1%	no response

3. Circulation

Because of the emphasis placed on circulation in the curriculum, the diploma examination contained a representative number of questions on circulation. The questions were all directly related to the human circulatory system, including the components and functions of the system. The specific topic statements covered by the examination were:

- the heart and blood vessels are structured to facilitate circulation
- blood is the primary circulating body fluid
- lymph is a secondary circulating body fluid
- homeostatic controls maintain cardiac output and blood pressure

In the following example the students are required to understand the various components of the circulatory system.

Question 31:

Use the following information to answer question 31.

The first heart sound is produced by the closing of the valves labelled

Student Responses

25.3%	A. 1 and 2
54.2%	*B. 1 and 3
14.5%	C. 2 and 4
6.0%	D. 3 and 4
0.0%	no response

4. Gas Exchange

Questions on gas exchange are related to the mechanics of breathing, the exchange and transport of gases in humans, and the homeostatic mechanisms required to maintain the systems involved. The specific topic statements covered by the examination were:

- mechanics of breathing include inhalation and exhalation
- gas exchange occurs between blood and body tissues
- blood is necessary for gas transport
- breathing rate is controlled by respiratory centres in the medulla
- blood oxygen levels affect the rate of red blood cell production

In the following example the students are required to recall knowledge related to the various components of the circulatory system.

Question 39:

Diffusion of carbon dioxide from the cells of the body to the capillaries and of oxygen to the cells of the body is due to

Student Responses

59.7%	*A. high cellular carbon dioxide and high capillary oxygen levels
20.6%	B. high capillary carbon dioxide and low cellular oxygen levels
13.0%	C. low capillary carbon dioxide and high cellular oxygen levels
6.6%	D. low cellular oxygen and low capillary oxygen levels
0.1%	no response

5. Cellular Respiration

The human organism must be able to supply its varying need for energy. Students must understand the three basic concepts of cellular aerobic and anaerobic respiration. They should be able to demonstrate their comprehension by applying the various concepts to the many energy-requiring human processes. The specific topic statements covered by the examination were:

- cellular respiration involves three basic concepts
- anaerobic respiration in muscle cells produces low amounts of ATP
- aerobic respiration utilizes oxygen as a final hydrogen acceptor, requires a cytochrome electron transfer system, and produces high amounts of ATP
- ATP released during cellular respiration is utilized for several metabolic processes including anabolism, movement and muscle contraction, heat production, and active transport

In the following example the students are required to recall knowledge related to cellular respiration.

Question 47:

The difference between anaerobic respiration in plants and anaerobic respiration in animals is that

Student Responses

47.4%	*A.	there is a difference in end-products
31.5%	B.	plants require sunlight for respiration, but animals do not
10.1%	C.	only one of them requires a carbohydrate as a starting substance
11.0%	D.	plants do not require oxygen, but animals need a minimal amount
0.2%		no response

6. Excretion

The study of the excretory system was limited to that found in humans. The anatomy of the entire system was studied in relation to the functions performed by the kidneys. Students were taught to view the excretory system as a homeostatic device. The specific topic statements covered by the examination were:

- the excretory system removes waste products from the blood
- body fluid balance is maintained by hormones and ions

In the following example the students are required to apply the principles learned concerning the kidneys as a homeostatic mechanism.

Question 56:

The inability of a pituitary gland to release an antidiuretic hormone (vasopressin) would inhibit the reabsorption of

Student Responses

68.1%	*A.	water
12.1%	B.	glucose
6.4%	C.	amino acids
13.3%	D.	sodium ions
0.2%		no response

7. Metabolic Controls

Regulation of the internal environment requires co-ordination between nervous and hormonal systems. Students should be able to understand the relationship between the two systems in the human body and to apply the principles involved. The specific topic statements covered by the examination were:

- nervous control involves reception, transmission, interpretation, and response
- endocrine secretions regulate and maintain bodily functions

In the following example the students are required to interpret given data using principles involving hormonal functions.

Question 66:

Use the following information to answer question 66.

A person who tires easily and uses less oxygen than normal has an underactive

Student Responses

4.1%	A. 3
15.9%	B. 4
14.1%	C. 6
65.8%	*D. 8
0.1%	no response

8. Human Reproduction

By understanding the development and function of the human male and female reproductive systems, students should be able to understand the fertilization process. The specific topic statements covered by the examination were:

- the anatomy of reproductive systems
- the development and functioning of the reproductive system is under the control of hormones
- the process of fertilization

In the following example the students are required to analyse a hypothetical situation based on the human reproductive cycle and to predict the outcome.

Question 80:

A malfunction of the placenta might cause premature birth because of

Student Responses

4.0%	A. a lack of proper ovulation
23.5%	B. excess progesterone secretion
10.3%	C. the endometrium beginning to increase in thickness
62.0%	*D. the lack of progesterone to prevent muscular contraction
0.4%	no response

9. Scientific Process Skills

The process skills covered by the examination were:

Observing - involves obtaining information about objects and situations by using the five senses.

Interpreting Data - the process of recognizing patterns in data, identifying relationships between variables, and forming generalizations.

Inferring - the process of arriving at a tentative explanation or conclusion based on direct or indirect observations.

Predicting - the process of formulating a specific forecast of what a future observation will be. Predicting often involves interpolating and extrapolating.

Hypothesizing - the process of proposing a tentative explanation, based on observations or inferences, for the occurrence of a set of observations or events. Hypotheses must be testable in order to be valid.

Recognizing and Identifying a Problem - involves speculating about observed phenomena. It also includes making assumptions about possible variables and being able to delimit the question under investigation in order to work toward a solution.

Processing Data - the process of organizing rough data in a more compact and meaningful way (through ordering, rearranging, comparing), depicting the data pictorially or graphically, and processing data mathematically (finding slopes, tangents, etc.) to facilitate interpretations.

In the following example the students are required to make a prediction by applying underlying principles to a hypothetical situation.

Question 17:

Use the following information to answer question 17.

In the diagram, the membrane is impermeable to the particles shown and permeable to water. The net movement of water will occur

Student Responses

20.6%	A. in both directions
21.2%	B. from side X to Y
46.2%	*C. from side Y to X
11.9%	D. in neither direction
0.1%	no response

Written-Response Questions

On the written-response portion of the examination, students were expected to communicate their answers clearly and show all steps in their solution. All eight written-response questions were designed to evaluate student performance at the cognitive levels of application, understanding, and higher mental activities.

Each written-response question from the examination is given on the following pages, along with an appropriate answer. The total marks possible for each question are given, as is with the average number of marks awarded. The distribution of marks awarded to students for each written-response question is shown in Table 6, Chapter 3.

Question 1 deals with cellular processes fundamental to life. Students must be able to apply principles regarding rate of enzymatic reaction in relation to temperature. Students must organize and process data and subsequently predict the structural and functional effects of temperature on the enzyme.

Use the following information to answer question 1.

The above graph represents normal human enzymatic activity. Complete the graph and explain what will happen at 45°C and for what reason.

Key: Enzymes have optimum temperatures for efficiency. The rate of reaction will increase slowly until the favorable temperature is reached. The reaction will occur at the maximum rate in this range. If the heat continues to rise the rate will drop sharply because enzymes are proteins and proteins are broken down by heat. Temperatures above 50°C are usually high enough to cause enzymes to break down.

The enzyme no longer combines with the substrate, therefore a higher activation energy is required to initiate the reaction (or more energy is needed to begin this reaction). Because of this, fewer reactions will occur per unit time.

1 mark - to complete graph (decrease indicated)

1 mark - enzyme structure altered (denatured, coagulated, critical temperature)

1 mark - the rate of reaction will decrease

or enzyme stops working

or enzyme inactivated/inhibited

Note: term "activation energy" not required - only the concept that the reaction without an enzyme requires more energy

It was possible to score 3 marks for this question. The average number of marks awarded to students was 1.87.

In question 2 students must organize and process data concerning photosynthesis. Students must also predict the effect on the stomata of osmotic pressure within guard cells.

Use the following information to answer question 2.

Internal Pressure of Leaf Cells as Recorded on a Sunny Summer Day		
Time	Pressure (kPa)	
	Guard Cells	Epidermal Cells
07:00	10	10
12:00	111	10
19:00	40	10

When is the pressure in the guard cells the greatest, and how do the stomata respond to it?

Key: Guard cell pressure is highest at noon when the light intensity is also greatest. High pressure in the guard cells causes the stomata to open, allowing CO₂ to diffuse in and be used in photosynthesis.

1 mark - noon (12:00)

or when light intensity is greatest

or when photosynthetic rate is highest

1 mark - high pressure in guard cells causes stomata to open thus enabling CO₂ to enter and be used in photosynthesis

It was possible to score 2 marks for this question. The average number of marks awarded to students was 1.48.

Question 3 deals with the human circulatory system. Students must identify problems that might arise from a defective septum depicted in a diagram of the mammalian heart.

Use the following information to answer question 3.

Ventral View of a Mammalian Heart (Diagrammatic)

Explain why an opening in the septum at W would be a serious disadvantage to anyone wanting to become an athlete.

Key: An opening in the septum would allow blood normally destined for pulmonary circulation to be shunted to the left ventricle and therefore into systemic circulation, where it would join blood that has just passed through the pulmonary system. Cells receiving such a mixture would not be receiving the maximum of oxygenated blood required for maximum cardiac output.

The reverse occurs when some of the blood returning from the lungs, instead of being routed to cells via systematic circulation, is routed though the septum to the right ventricle and from there to the pulmonary circulation. Hence, the lungs receive a mixture of oxygenated blood and deoxygenated blood.

1. Bypass pulmonary circulation allows the mixing of oxygenated and deoxygenated blood.
 2. The reduced oxygen content of the blood received by the body cells would limit the physical activity of the individual.
- There would be a lower concentration of oxygen in the blood that would in turn interfere with the respiratory process.

Marks - any two of the following:

- 1 mark - mixing of blood
- 1 mark - decrease in blood pressure
- 1 mark - less O₂ available for metabolism
- 1 mark - less energy generated in cells
- 1 mark - limitations to physical activity

It was possible to score 2 marks for this question. The average number of marks awarded to students was 1.19.

In question 4 students must recall and integrate the various concepts involved in the digestive process and make a prediction based on a given situation.

If an individual has an abnormally low secretion of gastrin, in what three ways would this affect the digestion of a meal that included steak and eggs fried in butter?

Key: Gastrin is secreted when food enters the pyloric end of the stomach. It diffuses into the bloodstream and when it reaches the stomach it stimulates gastric glands to secrete gastric juice.

- stimulate production of HCl by exocrine glands and digestive enzymes
- pepsin digests proteins in acidic environment (splits peptide bonds between amino acids)
- rennin curdles milk, taking proteins out of solution and making them more susceptible to proteolytic enzymes

1. Low level of gastrin - low level of gastric juices secreted
2. Less gastric juice, less protein digestion
3. Gastrin is a hormone that diffuses into the bloodstream and returns to the stomach to stimulate secretion of gastric juice

Marks - any three of the following:

- 1 mark - less gastric secretions (lipase, pepsin, HCl, rennin)
- 1 mark - less activation of pepsin or rennin
- 1 mark - less (slower) protein digestion
- 1 mark - less (slower) lipid digestion
- 1 mark - less (slower) mechanical digestion
- 1 mark - other digestive processes affected in small intestine

It was possible to score 3 marks for this question. The average number of marks awarded to students was 1.38.

In question 5 students must demonstrate an understanding of the process of excretion by explaining the principles involved.

A particular drug causes the afferent (incoming) renal arterioles to dilate, while constricting the efferent (outgoing) renal arterioles. Why would this drug act as a diuretic? (NOTE: A diuretic increases urine output.)

Key: More blood moves into the glomerulus but less blood moves out. This increases the blood pressure in the glomerulus, which in turn increases the force of filtration. Consequently, more fluids move into the nephron and out in the urine.

1 mark - more blood moves into the glomerulus (or nephron) but less blood moves out

or increased blood pressure in the kidney

1 mark - increased filtration

It was possible to score 2 marks for this question. The average number of marks awarded to students was 0.65.

In question 6 students are required to demonstrate comprehension of the function of the endocrine glands by explaining the role of the thyroid in maintaining the blood sugar levels.

Discuss ONE way in which a secretion of the thyroid gland assists in maintaining the blood sugar level.

Key: The thyroid gland manufactures thyroxin, a hormone that increases the rate of glucose oxidation (cellular respiration). Therefore, when thyroxin is present, glucose will be taken in by the cells, thereby maintaining a relatively low blood glucose level.

1 mark - the hormone is responsible for increasing rate of cellular respiration (metabolism, glucose utilization, burning, breakdown, etc.)

1 mark - higher rate of glucose utilization leads to lower blood glucose level (or the converse)

It was possible to score 2 marks for this question. The average number of marks awarded was 0.52.

In question 7 students must apply the principles of hormonal control involved in correcting hypoglycemia.

A person is suffering from hypoglycemia (low blood sugar). Which hormone, insulin, adrenalin, or thyroxin, might help that person? Explain your answer.

Key: Adrenalin controls conversion of glycogen to glucose in the liver. The glucose enters the blood and this raises the blood sugar level.

1 mark - adrenalin

1 mark - glycogen $\xrightarrow[\text{to}]{\text{conversion}}$ glucose

It was possible to score 2 marks for this question. The average number of marks awarded to students was 0.47.

In questions 8a and 8b students are required to illustrate the principles involved in neural membrane polarity. In question 8b students must summarize the steps involved in a nerve impulse.

- a. Sodium ions are pumped out of the neuron while potassium ions are pumped into the neuron by the sodium/potassium pump. If one positive ion is exchanged for another, how would you account for the polarity of the resting membrane?

Key: 1 mark - selective permeability of membrane

or concentration differences of positive/negative ions

or K^+ ions diffuse out of the nerve cell faster than Na^+ ions diffuse in (nerve cell membrane at rest is more permeable to K^+ than Na^+)

- 1 mark - therefore the outside of the nerve membrane contains more of a positive charge than the inside

- b. Explain why the polarity is reversed during an action potential (nerve impulse).

Key: 1 mark - permeability change

(during the passage of an impulse the nerve cell membrane becomes more permeable to Na^+ than to K^+)

1 mark - correct ion flow

(Na^+ rushes into the nerve cell faster than K^+ leaves - diffusion and charge attractions cause Na^+ to rush into the nerve cell creating a more positive charge on the inside of the nerve cell membrane)

It was possible to score 4 marks for this question. The average number of marks awarded to students was 0.89.

CHAPTER 3

Results

Validity and Reliability

The content validity of the examination was established by the procedure for examination development outlined in Chapter 2. Each question was mapped to a specific topic statement defining some aspect of the curriculum. The Examination Review Committee evaluated each question, and the examination as a whole, for content validity.

The KR-20 coefficient for the multiple-choice portion of the examination was 0.90, and Cronbach's alpha for the total test was 0.92. These values are very satisfactory for an achievement test measuring a broad range of concepts and skills.

The inter-marker reliability for the marking of the written-response questions was also examined. The marking key for each question was prepared by the Student Evaluation Branch and then revised following discussion with eleven head markers. During the orientation session, teachers marked three common student responses for each question and discussed the awarding of marks. All teachers then marked an additional three student responses for each question so that the consistency of the marking procedures could be checked. At the beginning of each morning and afternoon marking session, all teachers marked two common student responses for each question. Any discrepancies were again discussed. For questions on those papers marked by all teachers, 78.9% of the marks awarded were in agreement, 20.3% deviated from the consensus mark by one mark, and 0.8% deviated by more than one mark. During the marking, one teacher marked questions 1 to 4, and a different teacher marked questions 5 to 8 for each paper.

Provincial Averages

The classification of examination questions according to subject matter topic and cognitive level has been presented in Table 1, Chapter 2. Subtest scores were computed for each of the eight subject matter topics, for the three cognitive levels, and for the questions requiring the application of scientific process skills. Table 2 contains the provincial averages for these subtests and for the total examination. In each case, an average is given for the written-response questions, the multiple-choice questions, and the combination of the two (total). Averages are based on raw scores, which are the number of marks obtained on each subtest. The total marks possible are identified for the written-response and multiple-choice components of each subtest. For the multiple-choice component of each subtest, the average in per cent is also given.

Averages are based on the results achieved by 7894 students. Differences between total averages and component averages are due to rounding.

Table 2

Provincial Averages for Subtests

Subtest	Total Marks Possible		Raw Score Averages		
	Written-Response	Multiple-Choice	Written-Response	Multiple-Choice	Total
<u>Topics</u>					
Physical Properties of Cells	3	10	1.9	6.7 (66.6%)	8.5
Nutrition	5	16*	2.9	9.9 (61.6%)	12.7
Circulation	2	9	1.2	5.6 (62.1%)	6.8
Gas Exchange	0	8	--	5.5 (69.1%)	5.5
Cellular Respiration	0	6	--	3.8 (64.0%)	3.8
Excretion	2	6	0.6	3.6 (59.8%)	4.2
Metabolic Controls	8	17	1.9	10.5 (61.8%)	12.4
Human Reproduction	0	7	--	4.6 (66.3%)	4.6
Process Skills	18	31	7.9	19.9 (64.3%)	27.9
<u>Cognitive Levels</u>					
Knowledge	0	25	--	15.9 (63.6%)	15.9
Application and Understanding	16	44	7.8	27.4 (62.3%)	35.2
Higher Mental Activities	2	10	0.6	6.9 (69.0%)	7.5
Total Examination	20	79	8.4	50.2 (63.5%)	58.7

*Question 5 was omitted from the analysis.

The standard deviation for the total examination was 15.8 raw score points.

The multiple-choice averages in per cent provide an indication of how well students performed within subject matter topics and cognitive levels. The average for the multiple-choice questions on gas exchange is considerably higher than the overall average for the multiple-choice questions. The average for the multiple-choice questions on excretion is considerably lower than the overall average for the multiple-choice questions.

It is not meaningful to compare total subtest scores or written-response subtest scores across topics or cognitive levels because of the uneven distribution of written-response questions. However, jurisdictions and schools can compare their averages to the provincial averages to help identify strengths and weaknesses in their programs.

Comparison of Multiple-Choice and Written-Response Questions

The average mark attained on the multiple-choice section of the examination was 63.5%, and the average mark attained on the written-response section was 43.2%.

In comparing written-response and multiple-choice items based on the same curricular concepts, there is little similarity in terms of item difficulty. In nearly every case the difficulty level of the written-response questions is lower than those of the corresponding multiple-choice questions. In most cases, the difference is considerable. This would appear to imply that the students' difficulty with the written-response portion of the exam lies not in a general lack of comprehension of the concepts involved, but rather in the nature of the format of the required response.

In written-response question 1, students must be able to apply principles regarding enzymatic activity to the given graph. The difficulty level for this question is 0.62. Multiple-choice questions that deal with a similar concept have the following levels of difficulty:

Q. 20 - 0.72	Q. 23 - 0.84
Q. 21 - 0.69	Q. 24 - 0.70
Q. 22 - 0.50	

In written-response question 2, students must be able to apply principles concerning gaseous exchange in plants to the given data table. They must be able to recall the relationship that exists between guard cells and stomata. The difficulty level for this question is 0.74. Multiple-choice questions that deal with a similar concept have the following levels of difficulty:

Q. 1 - 0.47	Q. 4 - 0.81
Q. 2 - 0.35	Q. 6 - 0.80

In written-response question 3, students are required to demonstrate comprehension of the circulatory movement of blood in the heart. The difficulty level for this question is 0.60. The difficulty levels of multiple-choice questions that test a similar concept are as follows:

Q. 27 - 0.45	Q. 31 - 0.54
Q. 28 - 0.59	Q. 32 - 0.77
Q. 29 - 0.81	Q. 35 - 0.77
Q. 30 - 0.80	Q. 36 - 0.58

In written-response question 4, students must recall the process of digestion and apply that knowledge to this particular question. The level of difficulty for this question is 0.46. Multiple-choice questions that test a similar concept are:

Q. 14 - 0.75	Q. 17 - 0.90
Q. 15 - 0.78	

In written-response question 5, students must be able to demonstrate their understanding of the structure and function of the kidney by formulating a prediction specific for this given situation. This higher mental process question has a difficulty level of 0.32. The difficulty levels of multiple-choice questions that tested similar concepts are as follows:

Q. 52 - 0.76	Q. 56 - 0.68
Q. 53 - 0.31	

In written-response question 6, students are required to demonstrate their comprehension of the relationship that exists between homeostatic mechanisms and the body systems. This question can also be perceived as testing the students' comprehension of metabolic controls (specifically, a negative feedback system). The difficulty level for this question is 0.26. Multiple-choice questions that test a similar concept have the following difficulty levels:

Q. 57 - 0.63	Q. 65 - 0.43
Q. 58 - 0.50	Q. 66 - 0.66
Q. 62 - 0.56	Q. 67 - 0.64
Q. 63 - 0.55	Q. 68 - 0.35
Q. 64 - 0.65	Q. 73 - 0.64

In written-response question 7, students must demonstrate their comprehension of metabolic controls. They must be able to recall the function of each hormone and determine which hormone would be most effective in a given situation. The difficulty level for this question is 0.24. Multiple-choice questions that test a similar concept have the following difficulty levels:

Q. 57 - 0.63	Q. 65 - 0.43
Q. 58 - 0.50	Q. 66 - 0.66
Q. 62 - 0.56	Q. 67 - 0.64
Q. 63 - 0.55	Q. 68 - 0.35
Q. 64 - 0.65	Q. 73 - 0.64

In both sections of written-response question 8 students are required to demonstrate their understanding of neural transmission as it relates to neural structure. Question 8a requires students to form a hypothesis based upon a set of similar observations. Multiple-choice questions that test a similar concept have the following difficulty levels:

Q. 59 - 0.57	Q. 71 - 0.76
Q. 60 - 0.60	Q. 72 - 0.77
Q. 61 - 0.71	

Question 8b requires students to demonstrate comprehension of neural transmission by explaining the events that occur during an action potential. Multiple-choice questions that test a similar concept have the following difficulty levels:

Q. 57 - 0.63	Q. 65 - 0.43
Q. 58 - 0.50	Q. 66 - 0.66
Q. 62 - 0.56	Q. 67 - 0.64
Q. 63 - 0.55	Q. 68 - 0.35
Q. 64 - 0.65	Q. 73 - 0.64

The combined difficulty level for 8a and 8b is 0.22.

Standard-Setting

Every effort was made to design a Biology 30 diploma examination that would be a valid and reliable measure of what students can be expected to know as a result of instruction in this course. A specific standard or level of expectation inherent in the examination was established through careful test development procedures.

To ensure equitability among marks awarded to students during the administration of each examination form for 1984, the Student Evaluation Branch adopted a process of standard-setting. One way to review the standards inherent in each examination was to involve classroom teachers in making judgments about the difficulty of the examination.

The teachers who marked the written-response portion of the examination reviewed the difficulty level of each question in terms of borderline passing students (who merit 50%). A judgment was also made regarding borderline "B" students (who merit 65%), and borderline "A" students (who merit 80%). After teachers made their initial judgments on question difficulty, they were given information about the actual distribution of students' examination marks. They were then given the opportunity to modify their judgments.

On the basis of the data derived from the standard-setting procedure and an inspection of school-awarded marks, it was decided that transformation would not be required.

Relationship Between Examination Mark and School Mark

The provincial averages and standard deviations for the school-awarded mark, the examination mark, and the final blended mark are presented in Table 3.

Table 3

Summary Statistics for School Mark, Examination Mark, and Final Mark

	School-Awarded Mark	Examination Mark	Final Blended Mark
Average	64.7%	59.9%	63.0%
Standard Deviation	12.8%	16.0%	13.6%

The average school mark is 4.8% higher than the average examination mark. The correlation between school mark and examination mark is 0.75, which indicates a fairly close agreement in the rank-ordering of the students based on the two sets of marks.

The percentages of students receiving A's, B's, C's, and F's are presented in Table 4 for the school mark, the examination mark, and the final blended mark.

Table 4

Percentages of Students Receiving A's, B's, C's, and F's

Score	School-Awarded Mark	Examination Mark	Final Blended Mark
A(80-100%)	16.3	13.3	13.4
B(65-79%)	34.6	26.2	31.1
C(50-64%)	39.1	30.7	42.0
F(0-49%)	10.0	29.8	13.5

Results for Individual Questions

Multiple-Choice Questions

The percentage of students choosing each response for each multiple-choice question (item) is given in Table 5. The correct response (key) for each question is also identified.

Table 5

Results for Individual Multiple-Choice Questions

Item	Key	Distribution of Responses in %*				Item	Key	Distribution of Responses in %*			
		A	B	C	D			A	B	C	D
1	D	38.3	5.3	9.4	47.0	41	B	22.2	57.9	11.5	8.4
2	C	17.6	9.5	35.3	37.5	42	D	16.2	6.8	9.6	67.3
3	B	20.5	51.3	17.4	10.7	43	B	3.6	72.9	9.7	13.8
4	A	81.4	0.8	4.3	13.6	44	A	58.8	20.0	8.0	13.1
5	**					45	C	2.2	5.5	89.4	2.9
6	B	6.1	79.9	12.5	1.5	46	C	9.4	6.1	79.2	5.3
7	B	2.2	89.5	6.7	1.5	47	A	47.4	31.5	10.1	11.0
8	A	58.9	5.7	22.2	13.1	48	A	48.1	26.6	19.4	5.9
9	C	21.1	6.4	65.4	7.1	49	D	6.6	17.4	14.5	61.4
10	C	16.0	26.9	53.4	3.7	50	B	7.9	59.3	19.8	12.9
11	D	15.6	9.1	15.3	60.0	51	D	2.9	14.3	27.6	55.1
12	D	16.0	22.7	6.5	54.6	52	A	75.6	9.0	11.0	4.4
13	A	46.0	21.6	20.6	11.7	53	D	20.1	19.6	29.8	30.5
14	A	75.4	6.9	9.2	8.4	54	C	8.6	3.8	71.1	16.5
15	C	2.9	16.3	77.9	2.9	55	C	12.2	17.0	54.0	16.8
16	D	4.6	4.3	27.0	64.0	56	A	68.1	12.1	6.4	13.3
17	C	20.6	21.2	46.2	11.9	57	A	62.7	32.6	3.6	1.0
18	B	3.4	60.4	32.0	4.2	58	B	22.5	49.6	24.4	3.4
19	C	5.8	12.4	54.7	27.0	59	D	26.7	3.7	12.9	56.7
20	D	5.2	2.7	19.9	72.1	60	B	24.2	60.1	8.3	7.4
21	C	12.3	16.0	69.3	2.4	61	B	7.9	71.5	10.5	10.2
22	B	14.2	50.1	7.5	28.0	62	D	9.6	9.8	24.3	56.3
23	B	4.9	84.4	6.6	4.1	63	A	54.7	8.5	19.2	17.6
24	C	12.0	12.5	69.6	5.9	64	B	13.6	65.4	9.9	11.0
25	D	5.0	2.9	3.2	89.0	65	C	22.3	4.9	42.5	30.2
26	A	61.6	16.0	9.9	12.5	66	D	4.1	15.9	14.1	65.8
27	A	45.4	37.1	9.1	8.3	67	A	64.0	9.0	1.5	25.5
28	B	13.3	58.9	8.9	18.9	68	A	34.5	21.2	17.2	27.0
29	D	6.8	4.3	8.2	80.7	69	A	77.8	9.8	9.5	2.8
30	A	79.8	14.1	3.8	2.3	70	A	71.4	6.4	14.7	7.4
31	B	25.3	54.2	14.5	6.0	71	C	5.0	14.7	76.3	4.0
32	A	76.8	11.1	10.3	1.9	72	A	77.4	4.3	10.0	8.3
33	B	40.3	27.9	10.3	21.5	73	B	20.5	63.6	2.3	13.6
34	C	36.4	3.4	52.2	8.0	74	C	12.6	13.8	69.7	3.8
35	A	77.1	4.9	7.4	10.5	75	C	7.7	4.5	69.2	18.6
36	B	2.6	58.1	29.1	10.1	76	D	5.1	7.3	14.1	73.4
37	B	3.9	90.7	2.2	3.2	77	A	83.4	4.6	6.2	5.7
38	C	4.3	7.2	72.5	16.0	78	B	13.0	52.4	14.9	19.6
39	A	59.7	20.6	13.0	6.6	79	D	7.0	15.1	24.0	53.9
40	B	5.4	79.7	11.2	3.6	80	D	4.0	23.5	10.3	62.0

*The sum of the percentages for each question may be less than 100% because the No Response category is not included.

**Question 5 was omitted from the analysis.

Written-Response Questions

The percentage of students awarded each mark for each question is given in Table 6.

Table 6
Distribution of Marks for Written-Response Questions

Question Number	Percentage of Students Obtaining Each Mark					
	NR*	0	1	2	3	4
1	4.7	11.7	10.5	43.0	30.1	
2	1.4	3.9	41.2	53.5		
3	1.6	19.3	38.9	40.2		
4	3.3	15.9	37.5	29.6	13.7	
5	9.9	41.7	31.9	16.5		
6	12.6	53.2	16.6	17.6		
7	2.7	63.3	20.9	13.1		
8	12.2	42.7	19.5	12.5	7.7	5.3

*NR - No Response

The total number of marks possible, the average mark awarded to students, and the difficulty level for each written-response question are summarized in Table 7. The difficulty level is the average divided by total marks possible.

Table 7
Average Marks Awarded for Written-Response Questions

Question Number	Total Mark	Average Mark	Difficulty Level
1	3	1.9	0.62
2	2	1.5	0.74
3	2	1.2	0.60
4	3	1.4	0.46
5	2	0.6	0.32
6	2	0.5	0.26
7	2	0.5	0.24
8	4	0.9	0.22

N.L.C. - B.N.C.

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