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ABSTRACT

GRADES OR AGES: Grade 11 or 12. SUBJECT MATTER: Biology. ORGANIZATION AND PHYSICAL APPEARANCE: The guide is divided into four sections, each of which contains two-three units. All units are in list form. The guide is offset printed and staple-bound with a paper cover. OBJECTIVES AND ACTIVITIES: Several general objectives for the course are listed in the introduction. Each unit includes lists of topics to be covered and some suggestions for activities. Activities are primarily reading, discussion, or observation. INSTRUCTIONAL MATERIALS: A two-page bibliography is included at the end of the guide. STUDENT ASSESSMENT: No mention. (RT)

Curriculum RP-50

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ONTARIO
DEPARTMENT OF EDUCATION

BIOLOGY

AN OPTIONAL COURSE FOR
GRADE 11 OR GRADE 12 OF THE
FOUR-YEAR PROGRAMME

This course is experimental in that it will be subject to review. Suggestions for improvement will be welcomed.

GRADE 11 OR 12 BIOLOGY

THE THEME

The general theme of this course is "WHAT IS LIFE?"

The objectives of the course are:

1. To arouse a lasting interest in the living world
2. To introduce the major ideas of biology which are fundamental to an understanding of life
3. To develop an understanding of the methods of science

The introductory phase of the course is intended to arouse interest by acquainting students with a few of the organisms around them. The student should discover the basic characteristics of life and should see himself as an organism among other organisms. After this 'nodding acquaintance' with the diversity of life the student is led into a more detailed study of specific organisms. For that study the teacher should select from the list of suggested topics those that permit the exploration of local material and examples. The organisms should be so chosen as to lead to an understanding of what constitutes an organism. In order that the student may recognize that they are merely different manifestations of living matter, plants and animals should not be studied as such, but the stress should be on life. The student's awareness of the diversity of life around him should be increasing and he should begin to know what it means "to be alive". This will be more easily achieved if the teacher succeeds in developing an understanding of the concept that life is a process manifested in function. To understand function a knowledge of structure is essential.

Once the student attains some insight into what constitutes a living thing he goes on to explore the various ways which have been evolved for staying alive. This is done in a survey of a series of selected examples ranging from viruses to the higher plants and animals. A section on reproduction and genetics follows. This leads to a discussion of evolution in which selected examples may be re-examined on a phylogenetic basis.

As the course develops, the student should realize that he is an organism and is therefore part of THE COMMUNITY OR ORGANISMS. It should be stressed wherever possible that life is the unique quality that belongs to organisms and that, regardless of their position on the "tree of life", all living things display common qualities. The course concludes with units on ecological relationships with emphasis on the place of man in nature.

THE PLAN

WHAT IS LIFE?

Section A. THE DIVERSITY OF LIFE (13 periods)

- Unit I In what forms does life appear?
- Unit II Where does life occur?

Section B. WHAT IS AN ORGANISM? (72 periods)

- Unit I Characteristics of life
- Unit II The unit of structure and function of life - the cell
- Unit III A study of selected organisms in some detail

Section C. HOW DOES LIFE START AND HOW IS LIFE CONTINUED? (25 periods)

- Unit I How does life start?
- Unit II How is life continued?

Section D. THE COMMUNITY OF ORGANISMS (25 periods)

- Unit I How organisms live together
- Unit II Where do I fit in?

Note 1: In order to develop the theme of the course, it is necessary that the four sections A, B, C, and D should be taken in the order indicated. However, the topics within each of the sections may be taken in any order.

Note 2: The number of periods allocated for each of the main sections A, B, C, D, has been shown to indicate the proportion of time in order to carry the theme of the course, and these should be considered as fairly firm suggestions. Within each of the sections, however, and particularly in Section B, encouragement is given for a variation in depth and stress according to the particular interests of the pupils.

Note 3: Some items of the course specify a "recall of previous work". In order to identify the particular body of knowledge referred to, the "previous work" is identified by reference to particular grades, usually 10, but in some cases 9 and 8. It is to be understood that these references are to the content of Curriculum I:1(e) (1961) "Intermediate Division Science, Grades 7, 8, 9, 10", or of Curriculum RP-17, "Science".

THE COURSE

SECTION A: THE DIVERSITY OF LIFE (13 periods)

The aim of this section is to develop an awareness of the diversity of life. To achieve this aim, the section is to include the study of living organisms with attention to diversities of habitat, general structure, and habits.

Note 1: The study should include at least ten organisms.

Note 2: The organisms should be chosen to show the diversity of life as well as to take account of those to be studied in greater detail later in the course.

Note 3: Plants and animals in similar environments should be studied simultaneously.

Note 4: Preserved material, slides, films, pictures, and models may be used if living organisms are not readily available.

SUGGESTED LIST OF ORGANISMS

Terrestial Environment		Aquatic Environment		Parasitic Environment	
Plant	Animal	Plant	Animal	Plant	Animal
Mushroom	Earthworm	Vallisnaria	Clam	Rust	Louse
Potato	Mole	Sagittaria	Starfish	Mildew	Tick
Peanut	Termite	Algae	Planaria	Dodder	Lamprey
Mimosa	Sowbug	Elodea	Sponge	Mistletoe	Tapeworm
Radish	Garden slug	Duckweed	Daphnia	Yeast	
Lichen	Millipede	Water lily	Minnow		
Morning glory	Praying mantis	Cabomba	Snail		
Tomato	Fruit fly		Crab		
Corn	Bat		Paramoecium	Bacteria	
Geranium	Honey bee		Amoeba	Viruses	
Moss	Turtle				
Fern	Rat				
Tumbleweed					

Unit I: In what Forms Does Life Appear?

1. An introductory study of forms of life leading to the discovery that
   (a) organisms differ in adaptation
   (b) organisms show relationships to one another

Unit II: Where Does Life Occur?

1. A study of the occurrence of life in broad geographic regions such as the temperate zone, the rain forest, the desert, the arctic

2. A brief development of life in communities, using examples found locally

3. A discussion of the principle that life exploits all possibilities for living space
   (a) terrestial (land and air)
   (b) aquatic (fresh water and marine)
   (c) parasitic
   (d) micro-habitats

4. A reference to communities of the past
   The plant and animal record in fossils

SECTION B: WHAT IS AN ORGANISM (72 periods)

In this section, attention is directed to the broad answer to the question "What do we mean when we say that something is alive?" As the primary objective of this course is a study of "life", it is important that the data on the structure, function, and characteristics of life outlined in the first two units provide a foundation for the content of Unit III.

Unit I: Characteristics of Life

1. Review of the examples studied in Section A with a view to discovering characteristics that are common to all

2. Development of a short list of fundamental characteristics
   Discussion from this list to establish
   (a) that life is manifested to us as a process or a complex of processes
   (b) that life appears in all sorts of shapes and in a diversity of places
   (c) that, in general, living things have certain common characteristics
      (i) a specific form indicating a high degree of organization and integration, with the unit of the organization being the cell
      (ii) a dependence on a constant supply of energy to produce more living material and energy to drive the various processes such as nutrition (ingestion, digestion, and assimilation), catabolism (respiration resulting in release of energy), anabolism (synthesis, growth, and repair) and excretion of waste, with the energy from catabolic reactions being used to maintain the integrity of the organism and with the special feature of synthesis (anabolism) being the production of large molecules not ordinarily found outside organisms
      (iii) an ability to self-perpetuate as evidenced by their continuing to run on their own without outside adjustment, their regulatory processes, their short-term and long-term adaptations, and their means of reproduction.

Unit II: The Unit of Structure and Function of Life

1. A review of cell structure in sufficient detail to allow an understanding of function mentioning especially cell membranes (plasma and nuclear), mitochondria, endoplasmic reticulum, chromosomes, nucleolus

2. A study of cell function under the headings
   (a) Synthesis related to reduplication
   (b) Energy production related to mitochondria
   (c) Movement through membranes related to the selective properties of the membranes, diffusion, and osmosis
   (d) Control related to the role of the chromosomes, DNA, RNA, and the role of the nucleolus

3. The development of tissues
   (a) cell division
   (b) the concept of tissues and organs

Unit III: A Study of Selected Organisms in Some Detail

Note 1: The organisms studied in this unit can be arranged in a genealogical pattern. The students should begin with some knowledge of what is meant by a primitive organism. It can be pointed out that viruses are in a questionable area of living and non-living state. Through discussion, the students should note the similarities and differences of viruses to other organisms.

Note 2: Within the framework of the genealogical pattern mentioned in Note 1 above, comparisons should be made continually between organisms in order to point out why there is a necessity for greater complexity of structure to maintain the same basic functions common to all living things.

Note 3: There is more detail in this unit than can be covered in the time available. However, because the objective of the course requires a gradation from simple to complex organisms, alternatives are given at certain steps so that the whole of the gradation may be covered in the time available.

A: Viruses

1. Consideration of the minimal requirements in order for something to be alive.

2. Discussion of viruses as a packet of DNA or RNA wrapped in a protein coat with certain characteristics noted
   (a) very small (role of the electron microscope in study)
   (b) the fact that they can be crystallized suggesting some basic orderly and simple structure
   (c) the need of a living host cell in order to reproduce

3. Recall from previous work of the condition of widespread occurrence as parasites in both plants and animals in relation to rabies, polio, influenza, the common cold, measles, chicken pox, the mosaics of tobacco and legumes, the yellows of asters, peach, and chrysanthemum, and the breaking in the colour of tulips

4. Recall of the story of the work on vaccine by Edward Jenner (1798) Reference to Iwanowski's discovery in 1892 of viruses by filtering, as historical evidence of how science advances

B: Bacteria

A recall and extension of the previous study of bacteria as outlined in the Grade 10 course to include the following

1. A discussion as to what bacteria are

2. A culturing of bacteria in potato-dextrose broth and beef-peptone broth

3. A microscopic examination of colonies of bacteria and investigation of the conditions for growth

4. A microscopic examination of bacterial types from either student-stained slides or prepared ones

5. A discussion of the importance of bacteria, e.g., curing of tobacco, making of cheese, reduction of wastes and sewage, soil fertility, nitrogen fixation, nitrification and denitrification, diseases of plants and animals, spoilage of food stuffs

C: Algae

An expansion of the work on algae of the Grade 10 course, and including a study of the two examples treated under the following headings

1. Protococcus
   (a) Collection of samples from plant pots or bark of trees for microscopic examination
   (b) Brief treatment of the life history

2. Zygnema
   (a) Habitat
   (b) Examination of fresh or preserved material for structure
   (c) Life history

3. Introduction to photosynthesis

D: One only of D1: Fungi; D2: Liverworts and Mosses; D3: Ferns and Fern Allies

D1: Fungi

1. A recall of knowledge of bread moulds, yeasts, and mushrooms as outlined in the Grade 10 course

2. A study of at least two additional fungi

3. A study of
   (a) Parasitism and saprophytism as they apply to fungi
   (b) Penicillium, cultured from potato-dextrose-agar and studied macroscopically and microscopically and using Roquefort or Camembert cheese as sources of innoculation
   (c) Recognition and means of control only of
      (i) mildews, e.g., downy mildew of grape
      (ii) blights, e.g., late blight of potato
      (iii) smuts, e.g., corn smut

   Note: Local forms to be substituted and emphasized where possible

4. A comparison with [illegible]ae, particularly in reference to photosynthesis

D2: Liverworts and Mosses

Note: This study should emphasize that they are among the representatives of the first land plants and should make some reference to the significant role of these plants in prehistoric times. It is important in the study of the life cycle of the representative plants of the liverwort and moss groups to emphasize at the appropriate places the two distinct plant stages, the one concerned with the vegetative means of reproduction, the other, with sexual reproduction.

1. Liverwort forms using one of Marchantia or Conocephalum under the headings
   (a) Habitat
   (b) Macroscopic and microscopic examination of thallus, rhizoids, soredia, male and female organs (antheridia and archegonia)
   (c) Life history: production of sperms and eggs and mechanics of fertilization, and vegetative reproduction

2. Moss forms using one of Polytrichum, Funaria, or Mnium under the following headings
   (a) Habitat - the bog, with special reference to plant associations
   (b) Macroscopic examination from fresh or preserved material to see the protonema, "leafy shoots", organs
   (c) Microscopic examination of male and female organs (antheridia and archegonia) from prepared slides
   (d) Life history: production of sperms and eggs and mechanics of fertilization, vegetative reproduction

3. Horticultural uses of liverworts and mosses

D3: Ferns and Fern Allies

This study will begin with the definition of a fern and a brief recall of the fern as studied in previous courses with particular reference to structure, life history, and methods of reproduction. Some reference should also be made to the significant role of these plants in prehistoric times.

1. Ferns in the home garden
   Ferns in window boxes
   Ferns as house plants
   How to grow ferns successfully

2. Other uses of ferns:
   Food (fiddle heads)
   Fuels (fossil ferns)
   Orchid culture (osmundine fibre)

3. The study of one of the fern allies, a common horsetail, Equisetum, or a club moss, Lycopodium, under the headings
   (a) Habitat
   (b) Macroscopic observations of fertile and non-fertile forms of the plant
   (c) Microscopic observations of dry and moistened spore cases

(d) Life history
(e) Importance of the common horsetail for the scouring qualities of the stems and the uses of club mosses for dried floral arrangements, for Christmas decorations and wreaths, and for the use of lycopodium powder for experiments

E: The Seed Plants

This is a detailed extension of the work done on seed plants in Grade 10.

Note: A complete treatment of Parts 1, 3, and 4 is essential to achieve the objectives of the course. The treatment of Part 2 may be varied according to the particular interests and previous experience of the pupils, and may actually be omitted without endangering the achievement of the objectives. Therefore, Part 2 is optional.

1. Characteristics
   (a) A recall of the meaning of the term seed plant and a brief discussion of the grouping of such plants into three sections
      (i) those with one cotyledon
      (ii) those with two cotyledons
      (iii) those with several cotyledons
   (b) A study of the characteristics of seed plants with one cotyledon, namely, parallel-veined leaves, floral parts in threes, vascular elements scattered through the ground parenchyma, usually deciducus
   (c) A study of the characteristics of seed plants with two cotyledons, namely, net-veined leaves, floral parts in fours or fives, vascular elements in a definite pattern, usually deciduous
   (d) A study of the characteristics of seed plants with several cotyledons, namely, needle or scale-like leaves, floral parts as a cluster of spirally-arranged scales (cone), vascular elements in a definite pattern, usually evergreen

2. Structures and Functions (Optional)
   (a) Definition of the root
      Germination of radish seeds to show the primary root, root hairs and regions of the root tip
      An experiment to show the region of elongation in a root
      A study of root hairs to establish functions, location, duration, structure, and herbaceous character
   (b) Definition of the stem
      A study of the external features and cross sections of several woody and herbaceous stems such as corn, poplar, basswood, horse chestnut, clover, buttercup, and pine to establish structure and functions of the stem
      A study of buds such as cabbage, Brussels sprouts, horse chestnut to establish structure, functions, and a general classification of buds
   (c) Definition of the leaf
      A study of structure and functions of the leaf
      A discussion of leaf colouration as related to climatic conditions
   (d) Definition of the flower
      A recall of the whorl arrangement of parts of a typical flower
      Diagrams to show arrangements of floral parts and longitudinal sections through the flowers

A study of types of flowers by examination of samples from each of the groups:
(i) those of one cotyledon, e.g., tulip, lily
(ii) those of two cotyledons, e.g., Canada thistle, goat's beard
(iii) those of several cotyledons, e.g., pine and spruce cones
A study of inflorescensce to establish the forms such as raceme, catkin, umbel, head corymb, and spike

(e) Definition of the fruit
Definition of the seed
Dissemination of fruits and seeds (at least five ways)

(f) Definition of a weed
Establishment of the fact that some plants are weeds because of their efficient methods of seed and fruit production

3. Practical Work

(a) Related to Roots
(i) Attention to structure, function, and location of root hairs in root pruning, transplanting, and in feeding of plants and trees
(ii) The influence of phosphorus on root development
The meaning of labels on commercial fertilizers as 7: 7: 7 (in order N: P: K)
(iii) The significance of root 'breathing' in prevention of the 'drowning' of potted plants
Discussion of beaver dams and their effect on trees
(iv) The effect of soil texture, soil fertility, and watering on root development
Special considerations in the feeding and watering of conifers
(v) Experiments in testing for sugars in roots as a basis for a discussion of foods and food storage

(b) Related to Stems
(i) Practical work of propagation of plants by stem cuttings, air layering, and the use of hormones
(ii) Home landscaping with shade and flowering trees
Use of evergreens and conifers in the home garden to provide year-round cover
(iii) Use of evergreens for forest planting, windbreaks, hedges, and ornamental planting using plants of different colours and shapes
(iv) How to plant a conifer
(v) Forcing bulbs

(c) Related to Leaves
(i) Control of transpiration by reduction of the number of shoots
(ii) Control of transpiration by regulating of the amount of shade and shelter given the plant
(iii) Control of transpiration by spraying with a latex compound

(d) Related to Seeds
(i) Sowing of seeds under glass and in a garden
Methods of sowing seeds
Precautions to be taken in sowing seeds
(ii) Transplanting seedlings
(iii) Growth control by lighting
(iv) How to start a lawn from seed
(v) Weed Control
Reference to herbicides

4. The Economic Importance
   A discussion of any five of the following
   (a) lumber
   (b) pulp and paper
   (c) textiles
   (d) synthetics
   (e) horticulture and nurseries
   (f) food
   (g) fodder
   (h) medicines

F: An Introduction to the "Genealogical Tree"

A survey of the characteristics of the plants studied to enable the students to arrange, as far as possible, these plants on a branch of the "Genealogical Tree". It is understood that the "tree" will be made more complete after a study of the animals.

G: Unicells

Large groups of organisms have developed in different directions on the genealogical tree. Near the "trunk" some organisms display characteristics that make it difficult to place them on the "tree". Such an organism is the Euglena, which has both plant and animal characteristics. This part is devoted to a study of this organism, specimens of which are obtainable from certain ponds or a biological supply house.

1. Euglena
   (a) Habitat
   (b) Microscopic observation of main features of structure, i.e., eye-spot, flagellum, chloroplasts, and other characteristics which help identify it
   (c) A study of a laboratory culture of Euglena from the original material and a discussion of how it lives and reproduces itself, and the optimum conditions for its growth and reproduction
   (d) A study of similarities and difference of this species with other unicells, i.e., cell walls versus cell membranes, and single cells versus colonial life

H: Protozoa

1. A recall of the work covered in the Grade 9 course on Amoeba and Paramoecium

2. An extension to include the following points
   (a) Protozoans that live within organisms, i.e., in man and other animals (parasites)
   Protozoans that live outside the organism, e.g., in the soil, in drinking water (free-living)
   (b) An aqueous medium is required by both parasitic or free-living protozoans
   (c) Protozoan diseases including the name of the diseases, organism affected, nature of the disease, and the protozoan responsible, e.g., malaria and sleeping sickness

I: Flatworms

Note: Students should recognize that there are several types of worms in different phyla, i.e., flatworms, round worms, segmented worms

1. A study of Planaria as illustrative of the gradation of unicells to tissues under the headings
   (a) Recognition of grouping of cells to form tissues and of tissues to form organs
   (b) A discussion of cell specialization leading to division of labour resulting in less independence of the cell but greater efficiency of the group

J: A Study of either of J1: Molluscs J2: Insects

J1: Molluscs

1. A study of the living fresh water clam, Lampsilis, or the mussel, Sphaerium, to note its definite form and shape, and its activities of breathing, locomotion, and feeding
   A recall of the characteristics of bilateral symmetry and an external skeleton from organisms of this type previously studied

2. A brief discussion of the digestive system, the nervous system, and the reproduction system to bring out the increased complexity of specialization in the clam as compared with Planaria

3. Dissection of a preserved clam to show the internal parts such as hinge, ligaments, muscles and attachments, foot, mouth, gills, and reproductive, digestive, and circulatory systems

4. A discussion of adaptations for survival

5. Recognition of other molluscs including oysters, snails, octopi, and squid

6. A discussion of the economic importance of molluscs generally and their relationship to man as
   (a) a source for foods
   (b) a source for pearls
   (c) disease carriers

J2: Insects

1. Using the honey bee, Apis, recall from Grade 8 such general characteristics as segmentation, bilateral symmetry, jointed appendages, external skeletal systems, metamorphosis types, the basic functions such as breathing

2. Recall features related to feeding, digestion, production of honey, wax, and bee bread

3. Using the honey bee, recall and extend the study of adaptive modifications such as moulting, colour patterns, colouration, explaining how they apparently came about and why they are successful

4. (a) A study of insect societies in general and of the honey bee in particular, stressing the significance of feeding larvae to produce various types of adults
   (b) Relating of the society organization with other insect societies such as those of ants and of termites, and reference to higher societies such as those of man

5. The care and maintenance of a small demonstration hive paying attention to the proper requirements of temperature, water, air, feeding, and the elimination of diseases and pests

6. Apiculture

7. A study of insects in general under the headings
   (a) identification of ten common insects and indication with reasons which are harmful, beneficial, or both
   (b) general factors affecting survival such as climate, weather, parasitism, and competition for food and living space
   (c) the use of insecticides and their values and hazards

K,L,M: The Vertebrates

This study of animals with backbones will stress the emergence of many of this type, and will lead to the recognition that these may be located as another branch on the "genealogical tree".

Note: The major vertebrate groups should be mentioned but not all are to be studied in detail. Those to be studied are

K: Fish
L1: Reptiles or L2: Birds
M: Mammals

K: Fish

1. A practical study of a living fish (the sunfish, Lepomis, or a local example) to recall features of habitat, reproduction and life history, and habits of feeding, breathing and locomotion

2. A study of its external features
   (a) the form of tail, fins, and scales; the location of fins, mouth, teeth, and eyes; and its colour characteristics to show how fish are adapted for a life in the water and to show how these features assist in preserving the race
   (b) the determining of the age by the scales
   (c) size in relation to age and food supply

3. A discussion of adaptations of fishes to various environments

4. A discussion of the characteristics of a 'true fish' as different from other so-called 'fish' such as crayfish, silver fish, starfish, lamprey, shark, and whale

5. Dissection of a fish for study of its internal organs
Stomach analyses of several fish, such as smelt, perch, sucker, catfish, sunfish, to study the food favoured by each

6. An extension of food chains involving fish

7. A general treatment and discussion using films, filmstrips, and other visual aids on any three of the following topics
   (a) Recognition of at least six Ontario game fishes
   (b) Fish habits such as the migration of trout and salmon, and the secondary sex characteristics related to mating
   (c) Fish management to include
      (i) Commercial fishing and principles of management as expressed in laws and regulations
      (ii) Angling and its relation to various forms of conservation, e.g., fish hatcheries, fish protection, and preservation of habitats
   (d) Methods of catching and preserving fish, and preparing them for food

8. A discussion of the economic importance of fish with attention to such uses as food, fertilizers, oils, and recreation

9. A study of fish culture as a hobby under the following headings
   (a) The preparation and care of aquaria
   (b) The kinds of aquatic plants and the types suitable for various fish
   (c) The associations of fish with other animals of similar living habits
   (d) Kinds of tropical fish, the conditions for rearing them, and their approximate costs

L: A Study of either of: L1: Reptiles L2: Birds

L1: Reptiles

1. (a) A study of the painted turtle, Chrysemya, or the snapping turtle, Chelydra, to observe habitat and those common external features such as scales and claws that differentiate the class from the amphibians studied in previous courses
   (b) A comparison with frogs and birds
   (c) A study of those external features that contribute to survival in the environment

2. Observations of the living habits including those of feeding, breathing, and locomotion

3. A discussion of dinosaurs referring to possible reasons for their disappearance

4. A brief discussion of other reptiles, lizards such as skink, snakes such as the poisonous pit viper rattler, and non-poisonous colubrids as represented by all other snakes native to Ontario

5. First aid treatment of snake bite

6. Recognition of four Ontario snakes

7. Reference to superstitions about snakes

8. Discussion of adaptations for a terrestrial environment
   Reference to reptiles being the first animals believed to have left the water completely
   The importance of the shelled egg and embryonic adaptations

9. A discussion of the value of reptiles with attention to their use as food, leather, and pest control, and to their predation of fish, birds and man

L2: Birds

1. A study of one of the crow, Corvus, the starling, Sturnus, or the English sparrow, Passer, using preserved specimens or taxidermist mounts to note details of colour, shape, size, limb modifications, plumage, bills, and feet

2. A discussion of the mechanics of breathing, feeding, locomotion, and reproduction, and adaptations in these

3. Dissection of a bird to observe the digestive system, the breathing system, the reproductive system, and the food in the crop

4. A discussion, using films, slides, colour film strips, magnetic tapes, records, and other audio-visual aids, of habitat, nesting, song, migration, banding, predation, moulting, mating, territoriality, and general behaviour

5. Recognition of ten native birds some of which are migrant and some non-migrant

6. A study of birds in their relationship to man under the headings
   (a) beneficial species
   (b) harmful species including pests
   (c) domestic birds and game birds

M: Mammals

1. (a) Practical observations from the study of a preserved animal (the fetal pig, Sus, or the white rat, Rattus) to note external characteristics such as body covering, limbs, teeth, and size of brain cases
   (b) A comparison of the adaptations of the particular species studied with the adaptations of other animals such as flying squirrels, bats, and elephants

2. Dissection of a specimen to observe the structure of organs related to digestion, breathing, circulation, excretion, reproduction, and special senses, co-relating them with man's where applicable

3. A discussion of feet, teeth, and other special features of gnawing types, egg-laying types, pouched types, insect-eating types, flesh-eating types, flying types, toothless types, hoofed types, erect types, fossil types

4. A discussion of Canadian and foreign game mammals
Domesticated mammals

5. A brief treatment of migration, hibernation, and population cycles and some inferences that may be drawn from these

6. Reference to secondary sex characteristics related to mating

7. Behaviour and how it helps maintain the species

8. Colouration in wild mammals and relationship to environment and to geographical and climatic conditions

9. Reference to methods of identification of mammals in the field by tracks and scats

10. Recognition of ten native mammals with a brief description of how each is suited to its environment

11. A discussion of mammals and their relationship to man
(a) Beneficial - as food, beasts of burden, for clothing, for hunting, followed by a discussion of conservation of the beneficial mammals
(b) Harmful - as disease carriers and as destroyers of food and property, and this to be followed by a discussion of man's attempts to control these harmful actions

N: The "Genealogical Tree" Continued

1. A review of the "Genealogical Tree" as developed in Part F above

2. The addition of the animals to this "tree"

O: What is an Organism?

A recapitulation of the whole of Section B to consider an answer to the question "What is an Organism?"

SECTION C: HOW DOES LIFE START AND HOW IS LIFE CONTINUED? (25 periods)

Now that life has been investigated along two branches of the genealogical tree, that is, the plant branch and the animal branch, the remainder of the course is a discussion of all life, that is, of the whole "tree", and not of plants or of animals.

Unit I: How Does Life Start?

1. Review from Grade 10 and extension of the historical view on the Spontaneous Generation of Life

2. A discussion and emphasis of the concept that life continues from life

3. Reference to the modern theory of the spontaneous generation of life from the chance organization of elements into molecules

Unit II: How Is Life Continued?

1. Discussion of the two possible ways in which life may be continued
   (a) by generation to generation
   (b) by chance modification

2. Further study of the continuity through generation to generation under the following headings, making use of examples studied in Section B where applicable
   (a) A discussion of different forms of reproduction: sexual, asexual, and ramifications of these
   (b) Characteristics passed on by the genes on chromosomes
   (c) A brief treatment of the control of enzymes by genes
   (d) Consideration of how the genes are transmitted from generation to generation in asexual and sexual types
   (e) A short review of fertilization
   (f) A brief reference to growth and development from the zygote, cell development, and differentiation
   (g) Some examples of inherited characteristics, e.g., colour blindness tongue rolling, P.T.C. taste test, blood groups, ear lobe, over-bite and under-bite, hairiness and non-hairiness on tomato plants, and blending of colours of the flowers of the petunia and the four-o'clock
   (h) Reference to duplication in generations with study of
      (i) the concept of individual variation
      (ii) the causes of variation
      (iii) the wide variety of gene arrangement in cell division leading to limited duplication in the following generation

3. (a) Further study of chance modifications developing the idea that these modifications that occur in organisms may help in the continuance of life if these modifications adapt them to their environment
   (b) A study of emergence of new forms through gene change (mutations) under the following headings
      (i) natural mutations
      (ii) man-induced mutations
      (iii) the survival of highly adaptive mutants
      (iv) stress of the idea that many slight variations by mutations gradually evolve into new forms
      (v) the role of isolation

SECTION D: THE COMMUNITY OF ORGANISMS (?5 periods)

Unit I: How Organisms Live Together

1. The nature of interdependence of forms on one another

2. A development of the concept of demes as a particular kind of organism in a particular area, e.g., hardwood or conifer forest

3. A development of the concept of biomes as a community of plants and animals, e.g., a beech-maple woods, a tall-grass prairie, a bog

4. Why biomes and demes exist

5. The change of biomes as related to plant successions with examples of logical order of these plant successions

6. The types of animals associated with each stage of plant succession and the importance of the environment to the animal in terms of food, cover, and competition

7. (a) A recall of food chains as developed in Grade 10
   (b) An extension of the food chain concept to include a consideration of the relationships between food producers and food consumers in terms of size, numbers, and weights of herbivors, carnivors, and omnivors
   (c) Relating the food chain concept to the transfer of energy from the sun through the plant and animal kingdom

Unit II: Where Do I Fit In?

1. (a) An introduction to man's place through a development of the idea that biomes and demes are dynamic rather than static but that they tend toward equilibrium
   (b) A reference to the fact that biomes tend to a natural succession but that man tends to upset the balance for himself and other creatures thus causing a speeding up of biome change
   (c) Discussions of how biome change can be kept to a minimum, or if changed, controlled to the advantage of all forms of life including man

2. (a) A definition of Conservation
   A discussion of Conservation to develop what it encompasses, e.g., soil, water, minerals, oils and gases, forests, wildlife, and man
   A brief treatment relating this topic to its significance in Geography
   (b) Categorization of resources into
      (i) resources that are renewable if properly managed
      (ii) resources that are non-renewable when used up and hence must be replaced by substitution
   (c) Study of
      (i) forest conservation practices
      (ii) wildlife management principles
   (d) Study of conservation of human resources with attention to
      (i) costs of human care and development, illnesses and accidents, premature death
      (ii) costs to the individual and society of prejudices of various kinds
      (iii) problems of population growth

3. (a) Consideration of the possibilities of other forms of life elsewhere in the universe and its implications for man
   (b) A discussion of the biological problems of space flight

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