A PRACTICAL COURSE IN BIOLOGY.

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Requests from hundreds of teachers—representing a majority of the states of the Union, and ranging over a period of over four years—for copies of the course of study used in this school have been so frequent and insistent that it seems best to publish the course in full. In several previous issues of this periodical, the writer has laid down some fundamentals which he believes important in the teaching of Practical Biology.

The course here fully outlined is not a complete and final exposition of these fundamentals. The reason for this is obvious when one considers that the course was, originally, the work of three men belonging to a department of eight persons, all possessing marked individual and more or less set views on the way biology should be taught. The battle was, has been and is being waged between the structuralists and functionists. The course here presented is a compromise. It is not fixed, nor is it final. It is changed as we grow by experience including success and failure. No course of study can be final today. When that stage comes, education will have begun to lose its power as a factor in social progress.

This course is adapted to cover the first year of the high school course, consisting of approximately 36 weeks of actual instruction of five periods a week. Laboratory work is done at the convenience of the teacher as far as the stated time is concerned. The time to be occupied by plant biology is 12 weeks; by animal biology, 9 weeks; by human biology, 15 weeks. The first half year's work ends at the conclusion of topic L on Insects. This plan tends to break down the plant, animal and human distinctions in the subject and give us a unit course.

The method and point of attack is obvious. The fundamental needs of living things are used as a basis of the work. These needs are developed in the work on plants; tested in the work on animals and given a practical application in the work on the human body. Function precedes structure; only enough structure is given in order that function may be understood; the common things are dwelt upon; hygiene is strongly emphasized; some idea of evolution is given; the whole course tends to become practical.

The philosophy of the course here outlined is given at length in the March, 1913 and January, 1914 issues of this magazine. It is here presented in full with the sincere hope that it may be of some practical use to the teacher of biology in the secondary school.

I. PLANT BIOLOGY.

A. *Study of the Plant as a Whole.*

1. Essential parts.
2. Functions of essential parts.
3. Life cycle.
4. Dependence of plant upon soil, air, moisture, heat, light, etc.

B. *Sources and Composition of Living Things.*

1. Origin of soil. Rocks (inorganic); addition of decayed plants and animals (organic).
2. Kinds of soil. Humus, loam, sand, clay, etc.; value of each to plant life.
3. Chemical elements and compounds in soil and air. Discussion of the general properties of carbon, oxygen, hydrogen, nitrogen, carbon dioxide, water, nitrates, sulphates, phosphates, as materials for food and tissue building.
4. Importance of oxygen to living things.
 - (a) Experiment to show oxidation and its results (heat, CO_2 , water).
 - (b) Experiment to produce CO_2 in germinating seeds. Identity of process and results in plant and animal.

C. *The Young Plant. (Seeds and Seedlings.)*

1. Function of seed-reproduction.
2. Conditions necessary for germination.
3. Gross structure.
 - (a) Seed coats and uses.
 - (b) Embryo parts (shoot, root, seed, leaf) and uses.
 - (c) Endosperm (when present).
4. Demonstrations.
 - (a) Nutrients.
 - (b) Food tests.
 - (c) Digestion of starch.
5. Drawings. Bean seed showing opened embryo.
6. Discussion of important changes in the various parts of the embryo during germination.
7. Discussion of seed selection by the farmer and horticulturist.
8. Economic importance of seeds as food, medicine, stimulants; manufactures and arts.

D. *Roots.*

1. Functions of roots, as
 - (a) Holdfasts.
 - (b) Absorbers of raw materials.
 - (c) Conductors of liquids.
 - (d) Storers of food.
 Demonstration of a root hair.
2. Gross structure—Epidermis, cortex, central cylinder, ducts, rootlets and root hairs demonstrated. Function of each. Development of idea of the *plant cell*.
3. Method of securing food.
 - (a) Sources of raw materials—air, soil, water, other plants (parasitic).
 - (b) Substances absorbed by root hairs.
 - (c) Experiment on osmosis and application to the work of root hairs.
4. Food conduction illustrated by an experiment to show the rise of red ink in a carrot or parsnip.

5. Economic importance of roots as food, condiments, medicines, beverages, and in nitrogen fixation.

E. Stems.

1. Function of stems.
 - (a) Support. Monocot—rind. Dicot—bark wood.
 - (b) Conduction. Monocot—ducts. Dicot—sieve tubes, ducts.
 - (c) Food storage. Monocot—pith. Dicot—medullary rays, pith, sap wood.
2. Gross structure.
 - (a) Monocotyledon—rind, pith, ducts.
 - (b) Dicotyledon—bark (sieve tubes), cambium, wood (ducts), medullary rays, pith.
3. Drawings of gross structure of the longitudinal or cross section of a corn stem and the external view and cross section of a horse chestnut twig.
4. Economic importance of stems as food, medicine, in manufacture and arts. By-products. Value of five commonly used woods (oak, pine, maple, cherry, hickory).
5. Care of trees.
 - (a) Pruning. Use to plant.
 - (b) Protection against animals, insects and disease.
 - (c) Conditions for proper growth (space, light, soil, water).
 - (d) Civic value (beauty, equalizer of temperature, bird homes, enhancement of property value).
6. Methods of propagation.
 - (a) Grafting and budding (apple, etc.). Purpose and necessary conditions.
 - (b) Stem cuttings (geranium).
 - (c) Underground stems (potato).

F. Leaves.

1. Function of leaf—food manufacture.
2. Substances taken into leaf from air (O ; CO_2); from the stem H_2O and dissolved materials).
3. Processes carried on by leaf. Discussion of starch making. Use of sugar and starch by the plant. Digestion defined and illustrated by seeds and seedlings.
4. Other processes—respiration and transpiration.
5. Demonstration: Liberation of H_2O by the leaf.
6. Structure of leaf and use of parts—veins, epidermis, stomata, chlorophyll.
7. Drawing of leaf cross section from microscopic slide, chart or book aided by discussion.
8. Drawing of stoma, and adjacent cells in same manner as in (9).
9. Discussion of the effect of light on carbohydrate manufacture and leaf movements. Demonstration. Window plant's response to light.
10. Economic importance of leaves as food, stimulants, narcotics, soil enrichers, decoration.

G. Flowers.

1. Function—seed formation.
2. Gross structure and use of parts.
 - (a) Essential parts (stamens and pistils).
 - (b) Additional parts (sepals and petals).
3. Drawings. Flower (entire or in parts). Suggested forms:
Tulip or sweet pea or gladiolus.

4. Seed formation.

Step 1. Pollination.

- (a) Kinds (cross—self).
- (b) Agents (wind, insect, man).
- (c) Methods (natural, artificial).
- (d) Prevention of self-pollination (imperfect flowers, irregularity, unequal maturing of essential parts).
- (e) Modification to use agents of dispersal (pollen, nectar, odor, color, etc.).

Step 2. Fertilization.

- (a) Essential conditions. Union of essential parts of ovule and pollen.
- (b) Location and cellular nature of pollen and ovule.

Step 3. Changes following fertilization.

- (a) Loss of parts—stamens and petals.
- (b) Enlargement of parts. Cell division and development of embryo.
- (c) Storage of food.
- (d) Comparison of seed and its formation to mother and offspring.

5. Economic importance of flowers as food, medicine, perfume, condiment, decoration.

H. *Fruits.*

1. Function: Seed protection and seed distribution.
2. Gross structure and use of parts. Ovary, seed, connected parts.
3. Types of fruits: Dry—pea; fleshy—apple.
4. Necessity of dispersal.
 - (a) Natural—by agents and adaptations.
 - (b) Artificial—by man. Purpose and results.
5. Drawing of longitudinal section of apple, or pea fruit, to show origin of parts in the flower.
6. Production of new varieties and increase of yield by hybridizing, selection and grafting. Work of Luther Burbank and others.
7. Economic importance of fruits as food, medicine, extracts, etc.

I. *Conservation of Natural Resources.*

1. Wealth of the nation depends upon natural resources composed of water, minerals, soil, animals and vegetation (forests, crops, by-products).
2. Uses of the forest: Lumber, soil preserver, water reservoir, temperature equalizer, soil enricher, bird shelter, food, medicine, beauty.
3. Dangers to forests: Fires, storms, insects, disease, man, lumberman.
4. Conservation by city, state and nation.
 - (a) Methods used against dangers to the forests.
 - (b) National parks, reserves, nurseries, parks.
 - (c) Co-operation of the individual with city-park departments, state and national bureaus.
 - (d) Reclamation. Purpose and results.
 - (e) Crops.
 - (1.) Value of country (10 leading crops).
 - (2.) Dangers to crops (insects and disease).
 - (3.) Assistance of state and national departments of agriculture.

Illustrated lecture on forestry or visit to museum suggested (optional).

J. Discussion and Review of the Fundamentals of Plant Biology and the Development of the Great Needs of Plants.

1. Need of food.
2. Need of air.
3. Need of reproduction.
4. Need of protection with special emphasis upon the inadequacy of natural means to protect plants and the consequent development of conservation.

II. ANIMAL BIOLOGY.

K. Introduction.

1. Relation of animals to wealth of the nation.
 - (a) Useful.
 - (1.) Direct.
 - (2.) Indirect.
 - (b) Harmful, affecting agriculture and producing disease.
2. Listing of common animals affecting the wealth of the nation.
3. Chief groups of the animal kingdom.

Sub-Kingdom—Invertebrates.

 - Branch 1. Protozoa (unicellular animals)—amoeba.
 - Branch 2. Porifera (pore bearing animals)—sponges.
 - Branch 3. Coelenterata (hollow stomached animals)—jelly fish, corals.
 - Branch 4. Echinodermata (spiny skinned animals)—star fishes.
 - Branch 5. Vermes—worms.
 - Branch 6. Mollusca (soft bodied animals)—clams, oysters, snails.
 - Branch 7. Arthropoda (jointed legged animals).
 - Class I. Crustacea—crabs, lobsters, etc.
 - Class II. Myriapoda—centipeds, etc.
 - Class III. Arachnida—spiders.
 - Class IV. Hexapoda—insects.

Sub-Kingdom—Vertebrates.

 - Branch 1. Chordata.
 - Class I. Pisces—fishes.
 - Class II. Amphibia—frog.
 - Class III. Reptilia—snake, lizard, turtle, alligator.
 - Class IV. Aves—birds.
 - Class V. Mammalia—dog, rabbit, horse, man.

L. Grasshopper as a Type of Biting Insect.

1. Reasons for study of this form as developed from the general survey of animal kingdom.
2. Conditions necessary for life with emphasis on *food-getting*.
 - (a) Need of food.
 - (1.) Kinds of food. Effect upon crops.
 - (2.) Methods of obtaining food.
 - (3.) Adaptations of mouth parts for feeding.
 - (4.) Drawing of side view of grasshopper.
 - (b) Need of air.
 - (1.) Method of breathing (respiration).
 - (2.) Adaptation for breathing, trachea, spiracles.
 - (3.) Demonstration of trachea.
 - (c) Need of reproduction.
 - (1.) Life cycle (incomplete metamorphosis).
Fertilization, egg laying, immature (nymph), adult.

- (2.) Life cycle of one other insect (complete metamorphosis).
Fertilization, egg laying, larva, pupa, adult.
- (d) Need of protection.
 - (1.) Defensive. Coloration, locomotion, body covering, etc.
 - (2.) Offensive—none.
- (e) Economic importance of insects.
 - (1.) Useful—pollination, honey, insect destroyers, silk.
 - (2.) Harmful—crop destruction, fabric destruction and carriers of disease.
 - (3.) Methods of destroying injurious insects. Natural (protection of birds, other insects, etc.). Artificial (sprays for biting, emulsions for sucking).
 - (4.) Co-operation of the state and national departments of agriculture.
 - (5.) Recognition of 10 common insects (optional).

M. *Perch as a Type of Fish.*

1. Conditions necessary for life with emphasis on *respiration*.
 - (a) Need of food.
 - (1.) Kinds of food.
 - (2.) Methods of obtaining food. Structures adapted for this purpose (paired and unpaired fins). Relation to escape and higher animals.
 - (3.) Methods of feeding. Structures and their relation to the struggle for existence.
 - (4.) Drawing: Side view of fish.
 - (b) Need of air.
 - (1.) Method of breathing.
 - (2.) Structures for breathing. Gills, structure and protection. Adaptation for obtaining maximum amount of oxygen.
 - (3.) Drawing: One gill (removed).
 - (c) Need of reproduction.
 - (1.) Life cycle: Egg-laying, fertilization (external), young, adult. Number of eggs contrasted with lack of care by mother.
 - (d) Need of protection.
 - (1.) Defensive—color, scales, spines, fins, etc.
 - (2.) Offensive: Teeth and spines (in some cases).
 - (e) Economic importance of fishes.
 - (1.) Useful—food, fertilizer, by-products.
 - (2.) Harmful—destruction of food fishes.
 - (3.) Laws of protection (open and closed seasons). Hatcheries. Work of state and federal governments.
 - (4.) Recognition of 10 food fishes on field trip to aquarium (optional).

N. *Robin as a Type of Bird.*

1. Conditions necessary for life with emphasis upon *protection*.
 - (a) Need of food.
 - (1.) Kinds of food.
 - (2.) Method of obtaining food.
 - (3.) Method of feeding (bill, claws).
 - (b) Need of air.
 - (1.) Method of breathing.
 - (2.) Structures for breathing (nostrils, wind pipe, lungs).
 - (c) Need of reproduction.
 - (1.) Life cycle. Fertilization (internal), egg-laying (number,

- incubation, protection), young (helpless), adult. Decrease in number of offspring.
- (2.) Instincts: Song, mating, nesting, care of young, migration.
 - (d) Need of protection.
 - (1.) Defensive: Bills, claws, special senses, color, etc.
 - (2.) Offensive: Claws, bills.
 - (e) Economic importance of birds.
 - (1.) Useful.
 - (a) Direct: Meat, eggs, feathers.
 - (b) Indirect: Destroyers of insects, rodents; produce guano; song, beauty.
 - (2.) Harmful: Destroys fruits, seeds and trees.
 - (3.) Protective measures.
 - (a) Laws—open and closed seasons—shooting permits—tariff law—McLean migrating bird law, etc.
 - (b) Reservations, hatcheries.
 - (c) Audubon societies.
 - (d) Literature and public opinion.
 - (4.) Drawings of the bills and feet of three birds showing widely different structural adaptations. Recognition of 10 common birds from trip to museum (optional).

O. Rat as a Type of Mammal.

1. Conditions necessary for life with emphasis upon reproduction.

- (a) Need of food.
 - (1.) Kinds of food.
 - (2.) Methods of obtaining food.
 - (3.) Methods of feeding: Split lip, incisors.
 - (4.) A comparative study of the dentition of a rodent, a herbivore (cow), a carnivore (cat) and an omnivore (man). Drawings (optional).
- (b) Need of air.
 - (1.) Method of breathing.
 - (2.) Structures for breathing (nostrils, trachea, lungs) demonstrated from charts or mounted prepared specimen.
- (c) Need of reproduction.
 - (1.) Life cycle. Fertilization (internal), development of embryo attached to placenta and birth; young (helpless); adult. Decrease in number of young. Increase in attendant dangers to mother.
- (d) Need of protection.
 - (1.) Defensive in ungulates, carnivores and herbivores.
 - (2.) Offensive in ungulates, carnivores and herbivores.
- (e) Economic importance of mammals.
 - (1.) Useful: Food, medicines, clothing, draught animals, by-products, etc.
 - (2.) Harmful: Destroyers of crops, trees, useful animals, carriers of disease, etc.
 - (3.) Protective measures.
 - (a) Laws, open and closed seasons, etc.
 - (b) Reservations, etc.
 - (c) Societies and literature.

P. Parasites.

1. Important kinds: External (aphid, mosquito); internal (malaria, hook worm).

2. Animal parasites on plants (boll weevil, aphids, etc.)
3. Animal parasites on animals: Cattle (anthrax); man (hook worm, trichina, tape worm); protozoa (malaria).
4. Characteristics of parasites (internal) in general—atrophy of parts; great number of eggs; simple body structure.
5. Demonstration of living protozoa (paramoecium) by projectoscope to show simple body structure, fulfilling all needs of living things as an introduction to human biology.

Q. *Evolution of Animals.* (Showing increasing complexity from protozoa to man).

I. Invertebrates.

1. Protozoa (one celled)—no organs.
2. Sponges (many celled)—no organs.
3. Jelly fishes (many cells)—primitive organs.
4. Worms (many celled)—no well developed appendages.
5. Lobsters (many celled)—well developed appendages.
6. Insects (many celled)—well developed appendages.

II. Vertebrates.

1. Fishes (cold blooded—many celled)—well developed organs.
2. Frogs (cold blooded—many celled)—well developed organs.
3. Reptiles (cold blooded—many celled)—well developed organs.
4. Birds (warm blooded—many celled)—complex organs, instincts.
5. Man (warm blooded—many celled)—complex organs, intelligence. Evolution from water to land; from land to air.

III. HUMAN BIOLOGY.

1. Human body a cell aggregate fulfilling same needs as plants and protozoa.
2. Vital needs of living things.
 - (a) Digestion (circulation, excretion, assimilation).
 - (b) Respiration.
 - (c) Reproduction.
 - (d) Protection.

R. *Need of Food.*

1. Food as producer of heat and power.
2. Sources: Vegetable, animal, inorganic materials.
3. Composition.
 - (a) Nutrients (carbohydrates, fats, oils, protein) in common foods.
 - (b) Value of each to the body.
 - (c) Food preparation. Principles involved.
 - (d) Food economy: In purchase; in daily use in relation to occupation and climate.
 - (e) Food adulterants: Harmless; harmful.
 - (f) Food and drug laws to prevent
 - (1.) Adulteration.
 - (2.) Misbranding.
 - (3.) Reduced weight.
 - (g) Co-operation of nation, state and city in enforcing food laws, inspection, transportation and refrigeration of meats, milk and vegetables.

S. *Digestion of Food.*

1. Necessity for digestion of food.
2. Apparatus for digesting food.
 - (a) In mouth—teeth—kinds, number, functions, sets, structure.

hygiene; tongue—three uses; salivary glands—number, position, contents, use.

Experiment on digestion of starch.

(b) In throat—pharynx, tonsils, eustachian tubes, epiglottis, hygiene, no digestion.

(c) In stomach—shape, structure, muscle layers, mucous layer valves, gastric juices.

Experiment on digestion of proteid.

(d) In small intestine—muscle layers, villi, location, structure, number. Osmosis in relation to increased surface by folds and villi.

(e) Glands—liver—size, location, three functions (demonstration—bile and oil emulsion); pancreas—location, function, ferments.

(f) In large intestine—reservoir. Hygiene of intestines, regularity of habits, constipation, auto-intoxication, alcohol, narcotics.

(g) Common diseases of throat and intestines.

(h) Antidotes for common poisons (carbolic acid, arsenic, iodine, etc.).

T. Circulation of Food.

1. Need of circulation for supplying nutrients to the cells of the body.

2. Apparatus of circulation: Blood, heart, arteries, veins, capillaries, lymph.

(a) Blood structure.

(1.) Red corpuscles—use, number, structure, origin, destruction, hygiene in relation to (1) food, (2) air, (3) narcotics, (4) stimulants, (5) sleep, (6) exercise.

(2.) White corpuscles—use, number, origin, destruction.

(3.) Plasma—uses, structure, clot.

(4.) Blood diseases.

(b) Heart—position, size, protection, vessels, valves.

(c) Blood vessels.

(1.) Arteries—internal position, coats, pulse, use, reason for going to each vital organ.

(2.) Veins—external position, function, valves, portal vein.

(3.) Capillaries—size, position, use in relation to structure. Demonstration of blood in frog's foot.

(4.) Lymph—origin, use, composition (outline only).

3. Hygiene.

(a) Bleeding, fainting, first aid, dangers of exposed wounds.

(b) Distinction between food, stimulant, narcotic, poison.

(c) Moral, social, physiological and economic arguments against use of alcohol.

(d) Patent medicines.

U. Need of Air.

1. Purpose of oxygen to produce oxidation and release energy.

2. Apparatus for carrying oxygen to cells of the body.

(a) Lungs—size, position, protection, respiratory movements. Adaptations of mouth, nose, trachea. Ribs—muscles—diaphragm.

(b) Skin.

3. Composition of air. Gases. Relative quantities.

4. Changes in lungs during a respiratory movement (transfer of CO₂ and O by osmosis).

5. Oxidation—where carried on. By-products.
6. Hygiene. Respiration in relation to
 - (a) Dust and bacteria.
 - (b) Manner of breathing (shallow, deep).
 - (c) Occupations and disease.
 - (d) Ventilation.

V. Excretion.

1. Need of excretion.
2. Organs of excretion—lungs, kidneys, skin.
3. Hygiene—right habits, bathing, clothing, in relation to seasonal changes. Diseases of excretory organs.

W. Need of Protection.

1. Skeleton.
 - (a) Purpose—protection for vital organs and attachment for muscles.
 - (b) Structure—trunk, spinal column, ribs, girdles—appendages.
 - (c) Composition of bones—mineral, animal matter, articulation, maximum strength in relation to minimum weight.
 - (d) Hygiene: Fractures in young and old. First aid. Exercise. Deformity.
2. Muscles.
 - (a) Kinds—voluntary and involuntary.
 - (b) Structure—belly, tendon, attachment.
 - (c) Hygiene—exercise, sprain and treatment.
3. Nerves (body control).
 - (a) Need of co-ordination of body movements.
 - (b) Apparatus: Sense or receptive organs; brain or co-ordinating organ; muscles or moving organs. Connection by way of nerve fibres.
 - (c) Hygiene: Habit formation—shock and paralysis—sleep and quiet—eye strain. First aid.

X. Public and Individual Sanitation (Bacteria).

1. Bacteria—one celled plants.
2. Beneficial bacteria.
3. Harmful bacteria.
4. Conditions of growth.
5. Rate of growth.
6. Dispersal in
 - (a) Air and dust. Tuberculosis.
 - (b) Liquids: Milk, water, ice. Tuberculosis, typhoid.
 - (c) Solid foods. Ptomaine poisons.
 - (d) Animals including man: Bubonic plague, etc.
7. Methods of destruction.
8. Immunity—meaning of—natural and induced; vaccines and anti-toxins.
9. Municipal sanitation.
 - (a) Department of health—free examination of sputum, blood, urea, tubercular patients; free antitoxins, clinics, hospitals; quarantine; inspection of meat, milk, vegetables.
 - (b) Department of street cleaning. Function; coöperation.
 - (c) Department of sewers. Function; coöperation.
 - (d) Department of water supply. Inspection and guarding of water supply. Coöperation.

Y. Need of Reproduction (Biology of Sex).

1. Review of reproduction in bacteria, higher plants and animals.
2. Purpose of reproduction in living things. Man no exception.
3. Essential conditions of reproduction. Comparison of plant, insect, fish and bird. Union of two cells to form a third from which the new individual is to grow.
4. Development.
 - (a) Immature.
 - (b) Mature.
 - (c) Old.

Significance of each stage.

5. Hygiene.

- (a) Evil effects of abuse of body parts in connection with over exercise, eating and drinking, eye strain, over study. Abuse of reproductive organs no exception. Effect upon all other organs of body. Effect upon offspring.
- (b) Infection: Public lavatories, public drinking cups, towels, combs, etc. Transmission to relatives. Transmission to offspring.
- (c) Applications of eugenics. Contrast of Edwards and Juke family. Recent laws.
- (d) Chivalry versus morbid curiosity.

Z. Summary.

1. Inter-relation between animal, vegetable and mineral kingdoms.
2. Great biologists—Darwin, Pasteur, etc.
3. Evolution—general principle. Man, nature's greatest creation.

TELEPHONE GIRLS' EYES.

There are in the United States about 125,000 telephone girls, whose average term of service is three years or less. The working hours are about eight per diem; the average number of calls is about 140 per hour, running, "at the peak," to 225 or more. The operator sits facing a switchboard which is covered with numbers, each number having a small signal light that flashes on and off as the call is completed. When the person calling raises his receiver, a light flashes on the switchboard at "central," and this light continues to burn until the operator "plugs" the number and receives the call. She then plugs the number called for and this light burns until the called person raises his receiver from the hook. When the receivers are finally replaced on their hooks, both lights flash and burn until the operator removes the connecting plugs. To complete one call means four flashes of light. As the average number of calls is 140 per hour, with 225 or more during the rush hours, the operator's eyes are exposed to from 500 to 1,000 flashes of light every hour, resulting in fatigue to the eyes, to say nothing of the mental and physical strain under which the operator constantly works. The Bell system, in 1911, spent \$720,953 for rest-rooms and lunch-rooms for the operators, and it has secured sufficient air space and good illumination, yet, although only young and healthy girls are selected, the average length of service does not exceed three years. The symptoms of eye-strain which the girls develop are headache, dullness, indigestion, exhaustion, nerve strain, insomnia, colds, and so forth. The two or three short years of telephone work possible to the girls, as well as nine-tenths of all their suffering, is probably due to the constant near-range eyework, without proper protection for the eyes.