A TEACHING GUIDE

THE CHALLENGE OF CANCER

A Teaching Guide to

THE CHALLENGE OF

CANCER

This guide is designed to help the teacher use two education materials on cancer research, issued by the National Cancer Institute in cooperation with Canadian Government health agencies. These are The Challenge of Cancer, a 116-page book telling the how, what, and why of cancer research, and "Challenge: Science Against Cancer," a 35-minute documentary film on the story of cancer research.

Cancer research, one of the most important frontiers of modern science, provides many examples of progress in biology, chemistry, and physics—illustrations which the teacher can use to stimulate student interest in classroom subjects. Properly employed, the book and film can greatly enrich the science syllabus. The teaching suggestions given in this Guide show how the teacher can work these materials into the regular class outline and adapt them to the needs and abilities of the student group.

This Guide was prepared with the cooperation of the National Education Association, U. S. Office of Education, and the public school system of Prince Georges County, Maryland. The form of the Guide and its content were developed by the following committee of Prince Georges County teachers: Howard B. Owens, chairman; Mary E. Adams; Virginia C. Carney; Mary L. Davis; Thaddeus Elder, Jr.; Lillian Guis; Helena J. Haines; James E. Lauer; Lucille M. Richmond; Pauline E. Saunders, and Mary A. Thompson.

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INTRODUCTION

THE CHALLENGE OF CANCER presents one of the most fascinating problems in modern science. The major part of cancer research takes place upon the frontiers of scientific knowledge. In these regions, too often remote from the classroom, scientist explorers are finding new and peaceful uses for the power of the atom, thought-provoking facts about the intricate mechanisms of genetics, and unsuspected relationships in the complex chemistry of the cell.

In schools, cancer has been regarded primarily as a health education subject; most available material to date has emphasized this aspect. However, the study of cancer as a research problem can not only create better understanding of the disease, but can also bring new interest to purely scientific subjects.

For this reason, the National Cancer Institute has issued the book *The Challenge of Cancer,* the film "Challenge: Science Against Cancer" and this guide for teachers.

The Challenge of Cancer, by Lester Grant, is a 116-page book published under the joint sponsorship of the National Cancer Institute of the U. S. Public Health Service and the Canadian National Cancer Institute. It presents vividly and clearly the major phases of cancer research in a style that can be read and understood by the high school student.

The motion picture, "Challenge: Science Against Cancer," tells the exciting story of cancer research. It is the first science film ever made under international auspices, sponsored jointly by the National Cancer Institute, Public Health Service, and the Canadian Department of National Health and Welfare. It has received endorsements from the United Nations, the World Health Organization, and UNESCO.

This guide is designed to help the teacher make

best use of the book and film. The first part, Basic Facts About Cancer Research, serves to highlight the main points covered by the book and, more briefly, by the film. Following this are suggestions for using *The Challenge of Cancer* in classes, including correlations of subject matter usually taught in science classes with chapters in the book. Dozens of activities and projects, suitable for students ranging from the junior high level to the most advanced high school seniors, are given on pages 7–11. Also included are a list of teaching aids and a glossary.

It is not anticipated that cancer would often be taught as a separate unit. The most effective health education is that which takes place continuously and naturally. The subject of cancer can be worked into a course of study in many places and for various purposes. Sometimes it can be used to motivate a lesson; sometimes to indicate a practical application of a scientific principle; sometimes to illustrate a research method; sometimes to dramatize the progress of a science. Presented in this way, cancer education can enhance the regular work and enrich rather than overload the syllabus.

A unique feature of cancer research is that it enters into almost every aspect of the life sciences and into many of the neighboring sciences. Interest in the disease, aroused by the film or by many news stories which announce each scientific advance, can be channeled into new interest in the study of biology, chemistry, and physics. Fundamentally, the task of cancer research is to discover the mysterious laws which govern the growth of the cell, the basic unit of life. This is a challenge which can stir the imagination of almost every student.

Basic Facts About Cancer Research

The Problem

(See *The Challenge of Cancer,* chapters 1 to 3)

1. Cancer is abnormal, uncontrolled cell growth which tends to spread throughout the body.
2. Cancer appears not only in man, but also in animals, fish, and plants.
3. Cancer can be cured if all cancer cells are removed or destroyed.
4. Most types of cancer, if detected in time, can be cured by surgery or radiation.
5. Cancer appears most often after the age of 40, but no age is excluded.
6. In general, cancer death rates rise as the average age of the population rises.
7. Cancer is now second among the leading causes of death in the United States.
8. Cancer is basically a problem of abnormal cell growth.

The Cell

(See *The Challenge of Cancer,* chapters 4 and 5)

1. The cell is the basic unit of life.
2. Living cells, normal or cancerous, if carefully tended and fed, can be grown outside the body in glass flasks. This is called tissue culture.
3. The fertilized egg developes into the adult by cell growth, cell division, and cell differentiation.
4. When the adult stage is reached, normal cells continue to grow and divide but only to replace worn-out or injured cells.
5. In cancer, the cell (perhaps the nucleus, the chromosomes, the cytoplasm, or all three) is disturbed in some way which causes it to depart from its normal, useful function and to grow harmfully and unceasingly.
6. Regeneration, the replacing of destroyed tissue, is most striking in certain lower animals but is also present in humans.
7. Regeneration ability may be governed by "organizers," passed on to each cell from the original fertilized egg.
8. Cancer may be a type of growth appearing when the normal "organizer" fails for some reason to govern replacement of worn-out or injured cells.

The Environment

(See *The Challenge of Cancer,* chapter 6)

1. Environmental cancer was first described in 1775 by Dr. Percival Pott, of London, who noted the many cases of skin cancer among chimney sweeps caused by constant contact with soot.
2. Several carcinogens (cancer-causing agents) have been positively identified—certain

coal-tar products, X-rays, solar rays, emanations from radioactive materials, and arsenic, among others.

3. In certain industries and occupations where people are exposed to carcinogens for long periods of time, more cancer appears than would be normally expected.

4. Cancer *cannot* be caused by ordinary irritation or by a single blow or injury.

5. X-rays for chest, dental, or other examinations will not cause cancer if used under proper medical supervision.

6. In most cases, the cause of cancer is not known.

Isotopes

(See *The Challenge of Cancer,* chapters 7 and 8)

1. Isotopes, both stable and radioactive, show the same chemical behavior as the normal form of the atom and differ only in atomic weight.

2. Stable isotopes, which do not emit radiations, can be detected by means of a mass spectrometer, which shows the atomic weight of the atoms in any tissue or other substance.

3. By detecting in various organs the stable isotopes which have been fed or injected into experimental animals, the path of these elements can be traced through the body.

4. Radioactive isotopes can be detected by means of a Geiger counter and can also be used as "tracers."

5. Using radioactive or stable tracers, scientists study normal and cancerous tissue to learn how their metabolic processes differ.

6. Because thyroid tissue tends to absorb iodine, radioactive iodine can be used to detect and sometimes also to destroy thyroid cancer metastases.

7. Because brain tumors tend to absorb more phosphorus than normal brain tissue, radioactive phosphorus can be used by the surgeon to locate these tumors.

8. Artificial radioactive isotopes, such as radioactive cobalt, made in atomic reactors, may soon be used as substitutes for rare expensive radium in cancer treatment.

9. The Atomic Energy Commission supplies isotopes without charge to qualified cancer research workers.

Proteins, Enzymes, and Nucleic Acids

(See *The Challenge of Cancer,* chapters 9 to 11)

1. Proteins are extremely complex molecules which are essential to growth.

2. Genes, viruses, enzymes, and hormones all are proteins or contain proteins.

3. Proteins can be broken down into their component amino acids in the laboratory, but they can be built up from amino acids only in the living cell.

4. Amino acids are built up into proteins more rapidly in tumor tissue than in normal adult tissue.

5. Since cancer is apparently associated with changes in protein-building ability of the cell, cancer research seeks more information about how proteins are put together.

6. Enzymes are protein substances which make possible or speed up chemical reactions in the cell.

7. Different kinds of normal tissue show different and characteristic "enzyme profiles"; that is, they contain varying amounts of various enzymes.

8. When tissue becomes cancerous, the normal "enzyme profile" is apparently replaced by a new cancer "enzyme profile" which is very similar in all cancer tissue.

9. Nucleic acids are found in the cell—one type in the chromosomes and another type in the cytoplasm.

10. Nucleic acid is apparently one of the most important chemicals involved in cell division.

11. In cancer cells, nucleic acid is built up more rapidly than in normal cells.

12. Two substances found useful in treating cancer (although they are not able to cure cancer) are nitrogen mustard and antifolic acid compounds. These substances apparently slow down cell division by interfering with nucleic acid metabolism.

Viruses

(See *The Challenge of Cancer,* chapters 12 and 13)

1. A virus is a filterable protein, apparently a link between animate and inanimate matter, which can reproduce itself inside a living cell.

2. Viruses are so small that they can be seen only under an electron microscope.

3. A chicken cancer, the Rous sarcoma, can be transmitted from one bird to another by injection of a filtered tumor extract which apparently contains a virus.

4. A virus has been found in the milk of mice with breast cancer which pass this type of cancer on to their offspring.

5. Viruses appear to be "species specific"; that is, a virus which infects one animal will not "take" in another type of animal.

6. Thus, if viruses cause cancer, there must be many different viruses to cause different types of cancer in different animals.

7. There is no evidence that cancer in man is caused by a virus.

Genetics

(See *The Challenge of Cancer,* chapters 14 and 15)

1. Heredity is governed by genes, hypothetical units located in the thread-like chromosomes in the cell nucleus.

2. Genes in both the egg and sperm cells transmit hereditary traits of the parents to the offspring.

3. By mating mice brother to sister for dozens of generations, scientists obtain inbred strains of mice that are *almost* genetically identical.

4. In some of these inbred strains, 90% of the mice develop cancer; in other strains, few or none develop cancer.

5. These inbred strains of mice are used in cancer research because their hereditary make-up is constant and known.

6. Probably the only human beings who are genetically the same are identical twins because such twins develop from one fertilized egg.

7. Because members of human families vary so greatly in their genetic make-up, heredity is believed to be a very small factor in causing human cancer.

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Hormones

(See *The Challenge of Cancer,* chapters 16 and 17)

1. Hormone secretions of the endocrine glands affect and regulate growth, reproductive functions, and many mechanisms by which the body maintains its normal functions and physiological balances.

2. Experiments show that certain hormones can produce cancer in animals.

3. Several hormones are used to help in the treatment of cancer patients, causing tumors to stop growing and even to shrink temporarily, but not causing a permanent cure.

4. Evidence indicates that too much or too little of certain hormones may not only affect body growth and functions, but also affect the growth of certain types of cancer.

Nutrition

(See *The Challenge of Cancer,* chapter 18)

1. In mice and in men, scientists find that overweight individuals are more apt to develop cancer than underweight individuals.

2. Vitamin B complex and protein deficiencies may help produce cancer of the tongue in humans.

3. To reduce the chances of getting cancer (and many other diseases), doctors say that people should not eat too much but should eat plenty of protective foods.

Conclusion

(See *The Challenge of Cancer,* chapter 19)

1. The basic work of the cell is metabolism; that is, taking in foods and building them into living substances (anabolism), and breaking down living substances into waste products with the release of energy (catabolism).

2. Scientists know more about how catabolism works than about how anabolism works.

3. Cancer is a disorder of anabolism—cancer cells build up living tissues too fast and with harmful effects on the whole organism.

4. Cancer research is like a detective story in which the villain (the cancer cell) is known, but the puzzle is to find out how the crime is committed.

5. Clues to the mystery of cancer growth are being found by the biologist, the physicist, the chemist, and the physician.

6. When all the clues are put together, we will understand what cancer is and how it is caused; we will know how all cancer can be cured, and we will know a great deal about the nature of life itself.

Curriculum Suggestions

Elementary School

It is generally agreed that a study unit on cancer has no place in the elementary school. However, a discussion of cancer may arise in the upper elementary grades. If properly guided, such a discussion can be very effective in clearing up misconceptions and in combating possible fears regarding the disease. Although most of the scientific concepts involved in cancer research are beyond the elementary school level, the teacher may give the children a simple, basic understanding of cancer as abnormal cell growth and can also arouse interest in this and other medical research problems.

The Challenge of Cancer may serve as a reference book for the teacher of upper elementary grades. The teacher who has read this book will be able to recognize suitable situations for a discussion of the topic.

SUGGESTIONS

1. Children can be encouraged to look for news of scientific discoveries and to report on these to the rest of the class. Newspapers and magazines often report advances in cancer research. The teacher can guide discussion of these reports and lead the children into further reading and discussion on cancer and related scientific topics.

2. Fifth and sixth grade pupils are introduced to the growth and development of cells. As they study cell structure and observe types of cells under the microscope, the subject of diseased cells can be introduced. A study of diseased cells may lead into a discussion of cancer as a type of abnormal cell growth.

3. Fifth and sixth grade children are interested in biographies. As part of the health and science program, they have an opportunity to read about the lives of many "health heroes." The biography, *Madame Curie,* is written on the fifth grade level and can be used to introduce the subject of cancer research. (See page 15.)

Junior High School

In the junior high school, students show an awakening interest in science and in the world about them. Thus, cancer can be treated as a scientific research problem and may be brought to some extent into the general science class. The level of the discussion will, of course, depend on the students; some may have the interest and ability to undertake more advanced reading and activities than the rest of the class.

The Challenge of Cancer can serve chiefly as background reading for the teacher and, possibly, as optional reading for some of the students.

SUGGESTIONS FOR THE GENERAL SCIENCE TEACHER

1. When the subject is brought up by questions from a student who has a relative or friend with cancer, the teacher can take this opportunity to explain the disease as a type of abnormal cell growth, and to tell how it is treated and cured.

2. In the study of cells, the teacher can contrast normal and abnormal cell growth and also bring up the question of what regulates growth.

3. In explaining the scientific method, the teacher can contrast belief that cancer is caused by an injury with the scientifically proven fact that cancer can be caused by certain chemicals, or the belief in quack remedies with the fact that patients have been cured by surgery or radiation treatment given by reputable doctors.

4. In the study of infectious diseases, the teacher can contrast the noncontagious diseases such as cancer, heart disease, and diabetes.

5. In the study of radiation, the teacher can discuss the uses of X-rays and radium to destroy cancer cells.

6. Cancer may provide an example of a research problem which leads scientists into many fields of biology, physics, and chemistry.

7. Newspaper reports of cancer research discoveries may lead to discussions of this and related medical research.

8. For optional reading, the teacher may suggest some of the easier references given on pages 15–17.

9. For special individual or group projects, the teacher may suggest some of the simpler activities listed on pages 13 and 14.

Senior High School

In senior high school, many opportunities arise for using cancer research to demonstrate teaching points and to provide fascinating study subjects. At this level, many students are interested in becoming doctors or scientists and will want to undertake serious reading and relatively ambitious science projects.

The film, "Challenge: Science Against Cancer," is intended for highschool audiences. Its story can provide an excellent stimulus to further interest and can provide a jumping-off point for class discussions and projects related to medical research.

The Challenge of Cancer can be used as assigned reading for highschool students, as well as background reading for the teacher.

Suggestions for using these and other materials on cancer research in various highschool classes follow.

Biology

BIOLOGY TOPICS COVERED IN *THE CHALLENGE OF CANCER*

SOME BIOLOGY DISCUSSION QUESTIONS

Cells

1. What is the difference between normal cell growth and abnormal cell growth?
2. How can a cell live and grow outside of the body?
3. What are some things that control cell growth?
4. What is "cell differentiation"?
5. How would you explain the fact that simpler animals are able to regenerate lost parts better than more complex animals?

Viruses

1. Is a virus alive?
2. What is the virus theory of cancer?
3. Could all cancers be caused by a single type of virus?

Metabolism

1. What is metabolism?
2. Can you trace the metabolic path through the body of a chocolate bar? A lungful of air?
3. What seems to be the role of enzymes in metabolism?

Genetics

1. How do we account for the fact that some inbred mouse families show high cancer incidence?
2. Do mouse breeding experiments prove that cancer is inherited in humans?
3. Why are inbred mice used in cancer experiments?

Hormones

1. What are some of the body functions regulated by hormones?
2. How can some hormones cause cancer growth?
3. How do some hormones hinder cancer growth?

Chemistry

CHEMISTRY TOPICS COVERED IN *THE CHALLENGE OF CANCER*

SOME CHEMISTRY DISCUSSION QUESTIONS

Environment

1. What is a chemical carcinogen? Name some known and suspected carcinogens.

2. In what industrial occupations might people be exposed to carcinogens? In what nonindustrial occupations?

Isotopes

1. What is an isotope?
2. If normal carbon (C^{12}) is *chemically* the same as its isotope (C^{13}), how can one be distinguished from the other?
3. How can the scientist tell normal iodine (I^{127}) from its isotope (I^{131})?
4. How are isotopes used to trace chemical changes in the body?

Biochemistry

1. What is a protein? Name some protein foods, some body proteins.
2. How are proteins made? Where?
3. How is the body like a chemical factory?
4. Why does the scientist study differences in chemical activity of normal and cancer tissue?

Physics

PHYSICS TOPICS COVERED IN *THE CHALLENGE OF CANCER*

SOME PHYSICS DISCUSSION QUESTIONS

Radiant energy

1. What kinds of radiant energy are in our daily environment? What kinds are used in medical treatment?
2. What forms of radiant energy do we know that can cause cancer and can also be used to cure cancer?
3. How are X-rays produced?

Isotopes

1. What makes one element different from another?
2. How is a stable isotope different from the normal form of the element?
3. How are stable isotopes detected by the mass spectrometer?
4. How are isotopes made?
5. What makes an isotope radioactive?
6. What is the "half-life" of a radioactive isotope?
7. How does the Geiger counter work?
8. What isotopes are used to treat cancer? How?

Senior Science

Senior science, given in some high schools, is essentially an advanced course in general physical science. The primary need of students who take this course is a broad over-all view of science with relatively more detail than is provided by the junior high school general science class.

The topic correlations and discussion questions for senior science could be selected from those previously listed for biology, chemistry, and physics. The degree to which these, together with activities and teaching aids, may be used in a senior science syllabus must be determined according to the individual class situation.

Science Clubs

Science clubs, which have been organized in many schools, offer an excellent opportunity for students to take up more ambitious projects than can be undertaken within the time and curriculum limitations of regular science classes. A number of the activities listed on page 13 and 14 are suitable for such projects. By keeping informed of recent advances in cancer research, the faculty sponsor of the science club will be able to suggest additional research problems adapted to the abilities and interests of individual members.

In many schools a science fair is held during the spring semester to exhibit the results of these student projects. The many excellent projects related to cancer research displayed in science fairs in all parts of the country, and entered in various science talent searches, demonstrate the high quality of work that students can produce with adequate aid and encouragement.

Activities

CLASS DISCUSSIONS

1. Have oral reports, followed by class discussions, based on magazine or newspaper articles, radio or television shows, on cancer research.

2. Show the motion picture, "Challenge: Science Against Cancer," followed by class discussion.

3. Prepare a classroom debate on some subject such as:

a. Resolved: That research is more important than education in conquering cancer.

b. Resolved: That medical uses of atomic energy are more important than potential industrial uses.

TRIPS

1. Visit a museum or other institution having exhibits on cell growth, genetics, biochemistry, radioactive isotopes, etc.

2. Visit a university or other laboratory engaged in cancer research if it can be arranged to have a scientist explain some of the experimental work.

3. Visit a hospital if it can be arranged for a doctor to show and explain: (a) laboratory for preparation and examination of tissue specimens; (b) X-ray equipment for diagnosis and treatment; (c) radium and how it is handled.

4. Visit the local health department or cancer information center to find out about its educational and service programs.

NOTEBOOKS

1. Make a scrapbook of newspaper and magazine articles on cancer research.

2. Assemble an illustrated notebook of facts on the nature, causes, treatment, and prevention of cancer.

3. Make a notebook of pictures, with explanatory captions, showing equipment used in cancer research—electron microscope, mass spectrometer, Geiger counter, Carrel flask, microscope, microtome, etc.

EXHIBITS

(These subjects can be shown in many ways—by posters that use drawings, photographs, comic strip technique, diagrams, tables, or charts; by models made of wood, clay, metal, or cardboard; by presenting actual specimens mounted, in bottles, or on microscope slides; by lantern slides, movies, or microprojections.)

1. Different kinds of cells and what they do
2. Parts of a typical cell
3. How a cell divides (this can easily be seen in the cells of onion root tips).
4. Cell division brings growth in size
5. Cell differentiation into tissues, organs, and systems
6. Normal and abnormal cell growth
7. Benign and malignant tumors
8. How cancer spreads
9. The hormones and what they regulate
10. The body as a chemical factory
11. How proteins are made
12. Heredity and the genes
13. Mutations and how they appear
14. Inbred strains of mice
15. How mice help in cancer research
16. Carcinogens
17. Carcinogens in different occupations
18. What is an isotope?
19. How isotopes are made in the atomic reactor
20. How the Atomic Energy Commission aids cancer research
21. Isotopes used to study and treat cancer
22. The mass spectrometer
23. The Geiger counter
24. Half-life of different radioactive isotopes
25. The cyclotron and how it works
26. Sources of radium and uranium
27. The X-ray tube
28. How cancer is treated by X-rays
29. How cancer is treated by radium

30. The discovery of radium
31. The discovery of X-rays
32. Cancer mortality in the United States, your State, your county
33. Cancer is curable
34. How to make permanent slides
35. How to use a microscope
36. Differential staining of tissues

EXPERIMENTATION

1. Collect and examine plant galls, burls, and other unnatural growths on herbaceous and woody plants. Many galls are caused by chemical stimulation which may be excreted by insects when depositing eggs or by larvae within the gall. Place a burl in a shallow dish of water and notice that the new shoots springing from it are of normal growth.

2. Inoculate a bacterial culture of *Bacillus tumefaciens* into different parts of various herbaceous and woody plants and note the cancer-like crown galls which develop.

3. Grow tomato plants (or other herbaceous plants) to a height of 6 to 8 inches. Mix 1 part of indoleacetic acid, or other growth substance as naphthaleneacetic acid or indolebutyric acid, with 100 parts of lanolin. Apply with a glass rod along one side of a growing stem of the plant. If the rate of growth in that area is increased, the stem is caused to bend away from the treated side. If the concentration is too high, the growth is retarded and the stem bends toward the treated side. In this case dilute the mixture with more lanolin. If you apply the mixture to the upper side of a petiole, the growth at that spot forces a downward movement of the leaf. Within one or two hours, bending responses due to local cell enlargement may be observed. Increased cell division will continue until swelling occurs, followed by rupturing. Later, adventitious roots will appear.

4. Grow bean seedlings until the first compound leaf begins to spread out. Cut the stem off below the petiole of the compound leaf and apply lanolin containing indoleacetic acid in the proportion of 30 mg. per gm. of lanolin on the cut surface. Observe the tumors formed. A microscope slide preparation of a tumor may reveal the multinucleate condition of the cells.

5. Paint or inject diluted tar or a solution of ammonia in water at various points on the stems of sunflower, castor bean, or tomato plants. Proliferation of tissue will occur, and with hollow stems proliferation of the inner lining of the stem may result.

6. Stand a few young willow, poplar, or catalpa twigs in a gallon jar containing a small amount of water. If kept covered for a time, small local growths may appear at the lenticels.

7. Place a cap of black cloth over the upper part of a tomato plant for 10 days. Support the weight of the cap by stakes. Compare the plant's responses with those induced chemically.

8. Induce cancerous growths on laboratory animals by using carcinogenic substances.

9. Transplant cancerous tissue, natural or induced, into a laboratory animal by placing it just under the skin where it will grow in an area of flexible tissue.

Suggested Teaching Aids

BASIC REFERENCE

National Cancer Institute: *The Challenge of Cancer*. Washington 25, D. C., Government Printing Office, 1950. 116 pp. illustrated. Price 55 cents. Check or money order payable to Superintendent of Documents.

HIGH SCHOOL TEXTBOOKS

Bayles, E. E. and Mills, A. L.: *Basic Chemistry*. New York, Macmillan Company, 1947. pp. 264 and 270.

Carleton, R. H. and Carpenter, F. F.: *Chemistry for the New Age*. Philadelphia, J. B. Lippincott Company, 1949. pp. 68–70; 191–192; 224–238; 609–611.

Carleton, R. H. and Williams, H. H.: *Physics for the New Age*. Philadelphia, J. B. Lippincott Company, 1947. pp. 539; 597–617.

Curtis, F. D. and Urban, J.: *Biology in Daily Life*. New York, Ginn and Company, 1949. pp. 293–294.

Grant, C. L., Cady, H. K., and Neal, N. A.: *American High School Biology*. New York, Harper and Bros., 1948. pp. 450–451; 475–478.

Hunter, G. W. and Hunter, F. R.: *Biology in Our Lives*. New York, American Book Company, 1949. pp. 319–320.

Kroeber, E. and Wolff, W. H.: *Adventures With Animals and Plants*. Boston, D. C. Heath and Company, 1948. pp. 360–361.

Moon, T. J., Mann, P. B., and Otto, J. H.: *Modern Biology*. New York, Henry Holt and Company, 1947. pp. 571–572.

Price, W. E. and Bruce, G. H.: *Chemistry and Human Affairs*. Yonkers-on-Hudson, New York, World Book Company, 1946. p. 196.

Smallwood, W. M., Reveley, I. L., Bailey, G. A., and Dodge, R. A.: *Elements of Biology*. New York, Allyn and Bacon, 1948. pp. 354–355.

Smith, Ella T.: *Exploring Biology*. New York, Harcourt, Brace and Company, 1949. pp. 294–305; 464–465.

Wheat, F. M. and Fitzpatrick, E. T.: *Biology*. New York, American Book Company, 1949. pp. 280–281.

OTHER BOOKS

Curie, Eve: *Madame Curie*. New York, Doubleday, Doran and Company, Inc., 1938. A biography. (See also the shorter version of this book in the Metropolitan Life Insurance Co. "Health Heroes" series.)

Oberling, Charles: *The Riddle of Cancer*. New Haven, Conn., Yale University Press, 1944. A scholarly review of the progress research has made. Suggested reading for teachers and interested pupils.

Jaffe, Bernard: *Outposts of Science*. New York, Simon and Schuster, 1935. pp. 129–160. See chapter on the work of Maud Slye.

Jaffe, Bernard: *Conquests of Science*. New York, Simon and Schuster, 1939.

PAMPHLETS

Atomic Energy Here To Stay. Supp. to *School Life*. Washington 25, D. C., Office of Education, Federal Security Agency, March 1949. 13 pp.

Cancer: A Challenge To Youth. 47 Beaver Street, New York 4, N. Y., American Cancer Society, 1944. 16 pp.

Cancer: A Study for Laymen. 47 Beaver Street, New York 4, N. Y., American Cancer Society, 1944. 123 pp. A collection of articles on cancer, research and treatment.

Facing the Facts About Cancer. Bethesda 14, Md., National Cancer Institute, 1947. 31 pp. with charts. The problem of cancer and how science seeks to solve it.

Environmental Cancer. Bethesda 14, Md., National Cancer Institute, 1949. 19 pp.

Cancer: A Manual for High School Teachers. 130 E. 66th St., New York 21, N. Y., New York City Cancer Committee, 1947. 94 pp.

Teaching suggestions and information on cancer.

Selected Facts and Figures on Cancer. 47 Beaver St., New York 4, N. Y., American Cancer Society, 1949. 50 pp. Source book of statistics.

The U. S. Fights Cancer. Bethesda 14, Md., National Cancer Institute, 1948. About the National Cancer Institute.

Youth Looks at Cancer. Bronxville, New York, The Westchester Cancer Committee, 1942. 55 pp. Source of nontechnical information on cancer for high school and college students.

X-ray, Radium and Surgery. 47 Beaver St., New York 4, N. Y., American Cancer Society, 1947. 23 pp. illus. How cancer is treated.

ENCYCLOPEDIAS

Encyclopedia Americana. "Nature and Control of Cancer," and "Cause and Cure." New York, Americana Publisher, 1945. pp. 490–493.

Americana Annual. "Radioactive Salts Treatment." New York, Americana Publisher, 1941. p. 104.

Americana Annual. "Neutron." New York, Americana Publisher, 1941. p. 105.

Americana Annual. "Sex Hormones and Cancer." New York, Americana Publisher, 1945. p. 134.

Americana Annual. "Effects of Radiation." New York, Americana Publisher, 1945. p. 133.

Encyclopedia Britannica. "Early Symptoms and Later Symptoms," and "Cancer Control." Chicago, Britannica, Inc., 1940. pp. 731–734.

Britannica Book of the Year. "Neutron Beam and Betatron." Chicago, Britannica, Inc., 1943. p. 155.

Britannica Book of the Year. "Radiation." Chicago, Britannica, Inc., 1945. p. 157.

The World Book Encyclopedia. Chicago, The Quarrie Corporation, 1947. pp. 1206–1207.

PERIODICALS

See under "Cancer" and other headings in the *Readers Guide to Periodical Literature* and the *International Index to Periodicals.*

Science News Letter regularly contains brief articles on developments in cancer research.

Cancer News, monthly magazine of the American Cancer Society, features many articles on research and treatment. For example:

"Studies on environmental cancer," October 1949.

"Exfoliative cytology," June 1948.

"Cancer research," May 1948.

"Surgery in cancer," August-September 1947.

"The story of radium," July 1947.

"X-ray in cancer therapy," June 1947.

Scientific American presents many articles on cancer and related research subjects. For example:

Dobzhansky, T. "The genetic basis of evolution," January 1950.

"The AEC's isotopes," April 1949.

Kamen, Martin D. "Tracers," February 1949.

Conklin, Groff. "Cancer and the environment," January 1949.

Greene, H. S. N. "On the development of cancer," December 1948.

Pfeiffer, John E. "Enzymes," December 1948.

MOTION PICTURES

"Challenge: Science Against Cancer"

35-minute 16-mm. sound film telling the story of cancer research. (See *Introduction.*) Available on loan or rental basis from local film libraries. May be purchased through the Medical Film Institute, 2 East 103 St., New York 29, N. Y. Cost: $45.

Lewis "Living Cells"

18-minute 16-mm. silent film showing structure and activity of various normal and cancer cells in culture. Available through American Cancer Society divisions.

Suggested Teaching Aids

Canti "Living Cells"

20-minute 16-mm. silent film showing effect of radiation on various tissue cells. Also 10-minute version available through American Cancer Society divisions.

Chambers "Living Cells"

30-minute 16-mm. silent film showing tissue culture technique, physiological processes of normal cells, and cancer growth. Available through American Cancer Society divisions.

"The Traitor Within"

11-minute 16-mm. sound cartoon film on cancer diagnosis and treatment. Available from American Cancer Society divisions.

"The Battle Against Cancer"

12-minute 16-mm. sound film on cancer control and research. Available from American Cancer Society divisions.

Glossary

ACTH. Adreno-cortico-tropic hormone; secreted by the pituitary; stimulates hormone secretion by the adrenal cortex.

AMIN'O AC'ID. One of the building blocks of which proteins are made.

AN'DROGEN. Male sex hormone.

AN'TIBODY. A substance in blood or serum which acts against a toxin or other specific foreign substance entering the body.

AN'TIGEN. A substance which stimulates the formation of antibodies.

ATOM'IC REACT'OR. Place where isotopes are made by bombarding an element with radioactive particles (formerly called an atomic pile).

ATOM'IC WEIGHT. Relative weight of an atom of an element; e. g., the atomic weight for normal iodine is 127 and for radio-iodine is 131.

BI'OPSY. Removal of a bit of tissue from a living person for microscopic study; essential to accurate cancer diagnosis.

CAN'CER. An abnormal cell growth that tends to spread throughout the body.

CARCIN'OGEN. A cancer-causing substance or radiation.

CARCINO'MA. Cancer growth arising from epithelial tissue; compare *sarcoma.*

CELL. The structural and functional unit of plant and animal life.

CHRO'MOSOME. Thread-like body appearing in the cell *nucleus* before cell division; contains genes.

COR'TISONE. An adrenal hormone.

CROSS-MATING. Breeding two varieties of the same species; hybridizing.

CY'TOPLASM. Body of the *cell* exclusive of the *nucleus.*

DIFFERENTIA'TION. Development of various characteristics, as subdivision of the fertilized egg cell results in differentiation of various body cells.

ELEC'TRON MI'CROSCOPE. An optical instrument in which a beam of electrons produces an enlarged image of minute object on a fluorescent screen or photographic plate. Useful magnification is approximately 100 times greater than with a regular microscope.

EN'DOCRINE GLAND. Gland which secretes *hormones.*

EN'ZYME. A substance that aids metabolic processes; a catalyst.

ES'TROGEN. A female sex hormone.

FIL'TERABLE. (Biology) Capable of passing through a porcelain filter with very small pores, as a virus.

FO'LIC AC'ID. One of the B complex vitamins.

GEI'GER COUNT'ER. Electronic device to detect and measure radioactivity.

GENE. Hypothetical body in the chromosome which transmits hereditary factors.

GENET'ICALLY HOMOGE'NEOUS. Containing the same *genes;* having the identical *heredity;* genetically pure.

GO'NAD. A sex gland such as ovary, testis.

HERED'ITY. (Biology) The passing of characteristics from parents to offspring through the egg and sperm cells.

HODG'KINS DISEASE'. A disease causing inflammatory enlargement of the lymph nodes throughout the body, especially in the neck and spleen.

HOR'MONE. Internal body secretion into the blood stream which regulates body growth or functions.

IN'BRED STRAIN. Family in which brothers and sisters (or other close relatives) have been mated for many generations.

LEUKE'MIA. Cancer in which the number of white blood cells increases abnormally.

MALIG'NANT. Cancerous or tending to spread, as a malignant *tumor.* (Compare *benign* tumor).

MASS SPECTROM'ETER. An instrument which sorts molecules according to their relative weights. It is used for gas analysis and for isotopic ratio measurements.

MELANO'MA. A tumor containing dark pigment.

METAB'OLISM. The sum of processes conceived in building up living matter (anabolism) and tearing it down (catabolism) which take place continuously in the cell.

METAS'TASIS. The spread of cancer throughout the body by cancer cells carried in the blood or lymph. *Verb:* to metastasize.

MUTA'TION. (Biology) Variation in offspring caused by change in genes.

NUCLE'IC AC'ID. One of the sugar-containing acids found in the cell nucleus.

NU'CLEUS. A body in the cell which is important in metabolism, growth, reproduction, and heredity.

PAL'LIATE. To ease or improve a diseased condition without curing.

PITU'ITARY. Endocrine gland located at base of the brain.

PROGES'TERONE. A female sex hormone.

PROLIF'ERATE. To grow by cell division. *Noun:* proliferation.

PROS'TATE. A gland; part of the male reproductive organs.

PRO'TOPLASM. Living matter.

RADIOAC'TIVE I'SOTOPE. Form of an element which emits radiant energy; compare *stable isotope.*

REGENERA'TION. (Biology) Regrowth of removed or destroyed tissue.

SARCO'MA. Cancer growth arising from nonepithelial tissue; e. g., connective tissue, lymphoid tissue, cartilage, or bone. (Compare *carcinoma*).

STA'BLE I'SOTOPE. Form of an element which does not emit radiation but has a different *atomic weight* from the normal form of the element.

TIS'SUE. (Biology) A group of cells forming one of the body structures.

TIS'SUE CUL'TURE. Growth of a piece of tissue outside the body, as in a Carrel flask or planted in an egg.

TU'MOR. An abnormal growth of tissue. (Compare *benign* and *malignant* tumors).

VI'RUS. A filterable protein, capable of self-reproduction in a living cell; some viruses cause diseases in animals and plants.

X-RAYS. Penetrating short-wave radiations produced by cathode rays striking a target in vacuum; also called *Roentgen* rays after their discoverer.

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