

CHEMISTRY IN HEALTH AND DISEASE

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PREFACE TO THE FIFTH EDITION

THE Fifth Edition of Chemistry in Health and Disease was made necessary by new developments in the growing science of chemistry. All of the text of the Fourth Edition was surveyed critically. In the areas in which new theories had been advanced or teaching experience had pointed the way to improvement, appropriate changes were made. The addition of new material, particularly in the rapidly expanding field of metabolism, was also required. By careful planning, the revisions for the present volume were accomplished without adding substantially to the size of the book.

The features that contributed to the wide acceptance of the previous editions by both students and instructors have been retained in the present revision. At the beginning of each chapter are found: a review and preview—a summary of the preceding chapter and objectives of the chapter to be pursued, as aids and motivation for the student; chapter outline—for student and instructor. The self-testing questions interspersed throughout the text provide the student with a means of determining his or her understanding and retention of the subject matter. Included in the "Suggested Activities" at the end of each chapter are: "Thought-Provoking Questions," "Vocabulary Testing of New Terms," "Topics for Oral or Written Reports," and suggestions for "Display Posters, Charts, or Exhibits." Following Parts I, II, and III are reviews of definitions. The laboratory exercises—forming Part V of the book—are correlated with the chapters. Part IV consists of an appendix containing charts, tables, and other organized data useful to the chemistry student.

The purpose of this edition, as of the prior ones, is to give the student a foundation in chemistry which will include a knowledge of chemical facts and principles together with comprehension of the role of chemistry in health and disease.

The authors are grateful for the suggestions for improvements or change indicated by the nurses' needs and given by numerous instructors. Grateful acknowledgement is given to Dr. Alfred H. Free, chief chemist and head of the Biological Department of the Miles Laboratories, for the chapter on hormones. Suggestions from numerous correspondents, especially Sister Veronica, of Good Samaritan Hospital, Dayton, Ohio, have helped greatly in making the text what it is. The authors also wish to express appreciation to the staff of the F. A. Davis Company for continued cooperation, and to numerous individuals and organizations to whom they are indebted for permission for use of certain illustrations, as acknowledged throughout the book.

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PREFACE TO THE FIRST EDITION

THERE are many life situations in which an applied course in Chemistry is needed. In such instances, all of the ramifications of the science, such as its applications to the industries, are not needed. The medical student, for instance, is very much concerned with biological chemistry, as is the dietitian and student of nutrition, as well as the nurse. Again, there are many public health workers, and numerous technicians of various kinds who are not nurses, and yet are concerned with the application of chemistry in Health and Disease. It is true, that of all such groups, the nurse is the most vitally interested in such an application of Chemistry as that presented in this text.

The author feels that students taking an applied course in Chemistry need only a minimum of inorganic chemistry, especially as the importance of physiological chemistry is being more and more emphasized. At first glance, an instructor may feel that some topics in inorganic chemistry have been entirely eliminated from the text, whereas they are sufficiently covered in the Laboratory Work provided for each chapter.

Chemistry in Health and Disease has been divided into three major sections: *inorganic, organic, and biochemical*. The inorganic section is, of course, a necessary review for the entering student; however, it has been made into a functional discussion; as a consequence this section contains much useful information not ordinarily contained in many texts dealing with elementary inorganic chemistry. Moreover, since practically all of the principles of chemistry are considered in inorganic chemistry, this branch of chemistry must assume a prominent place in any text of this kind.

This text provides sufficient material for a sixty to a ninety-hour course and it presents a more extended development of organic chemistry than is given in any other similar text. That the student who has not had much of a background in organic chemistry might

better understand the principles of biochemistry, more than the usual discussion has been allotted to the development of organic principles, and in particular the chemistry of the carbohydrates, fats, and proteins. Much stress is laid upon biochemistry, which of course includes the chemistry of the blood and of the excretory products of the body, as well as chemical changes involved in metabolism, the role of vitamins in nutrition, and the chemistry of milk and other food products. More attention has been given to the chemical changes taking place in the body than has hitherto been presented in a text of this character.

It is a pleasure to acknowledge the author's indebtedness to Dr. Cecil E. Boord, Professor of Organic Chemistry, Ohio State University, for his constructive criticism of the chapters included in the organic section of this text; and to Frederic T. Jung, Ph.D., M.D., Associate Professor of Physiology, Northwestern University, for the improvement resulting from his criticisms of the chapter on Metabolism.

My sincere thanks and appreciation for the improvement of this text are due Dr. Anthony Sindoni, Jr., of Philadelphia, Pa., for his excellent fund of information and his personal contribution in writing the chapter on Vitamins.

Especial appreciation should be expressed to Miss Marion G. Howell, Dean of the Frances Payne Bolton School of Nursing, Western Reserve University, who made possible the opportunity to present this material in manuscript form to the author's classes.

H. C. B.

AN EFFECTIVE METHOD OF STUDYING CHEMISTRY

SINCE the greater part of the time devoted to any course is spent in preparation, it is necessary that the student form correct study habits for the assimilation of textbook material. In undertaking a study of any subject one certainly must have a knowledge of the objectives involved. These include the nature of the subject matter to be mastered, and a clear understanding of the facts and principles needed for dealing with the problems embraced in the subject.

Some of the factors in an effective method of studying chemistry have been established by an investigation of the study habits of numerous students who were successful in mastering this science. The following outline of the objectives in this course, together with suggestions for more effective study, should prove helpful.

I. FACTS AND PRINCIPLES

- (a) To know that many of the happenings in everyday life as well as hospital procedures are the result of chemical changes, and that our very existence depends upon them.
- (b) To understand the electrical nature of the atom and the principles involved in chemical changes.
- (c) To know the properties, uses, and behavior of certain elements, compounds, and classes of compounds.
- (d) To have a better understanding of the place and possibilities of chemistry in health and disease.

II. ATTITUDES

- (a) To develop a growing understanding of the practical applications of chemistry which furnish so many modern comforts.
- (b) To have a desire to select and learn the facts and principles which are necessary for the understanding of chemistry in the field of nursing.
- (c) To appreciate the value of health and to demand pure foods, drugs, and other substances necessary to health and social well-being.
- (d) To appreciate the numerous applications of chemical changes.

- (e) To develop a desire to learn the fundamentals of chemistry to the end that the current literature relating to the nursing profession may be read intelligently.
- (f) To develop an appreciation of the contributions that chemistry makes for the student's full development.

III. HOW TO STUDY

Study Where There Are No Interruptions:

It is much easier to concentrate where it is quiet, and where there are likely to be no interruptions. In other words, the right environment not only assists you in developing good study habits, but aids in conserving time, and time is one of the most valuable things in life. Each individual has 24 hours per day; no one has more. Time must be used where it is found. You cannot borrow two hours from today and use it tomorrow. Also, time lost can never be regained. For these reasons, plan to use your time wisely. Plan your work and then work your plan. Make a class- and study-schedule, and adhere to it. Experiences of student nurses indicate that finding sufficient time is a most important problem.

Consider the Value of the Subject:

Before beginning to study ask yourself whether the subject matter will be useful to you, not only in succeeding courses but also in the future practice of your profession. Only in this way can you stimulate and arouse sufficient interest to have a desire to master your assignments. If at any time interest lags and day-dreaming begins, think again of the handicaps that must be overcome by a nurse who is lacking in the fundamental principles of chemistry.

Acquire a Bird's-eye View of Each Assignment:

For those students who have had some previous training in chemistry it will be sufficient to read the "Chapter Outline" at the beginning of each chapter in order to gain a survey of its subject matter; but for those who have had no previous chemistry it will be necessary to read the preview to the chapter, the paragraph headings, or perhaps the entire chapter, as well as the review in the introduction to the following chapter. This should be done rapidly. The object is to gain a general idea of the main points of this chapter before beginning to study its details.

Make an Analytical Reading of Each Paragraph:

(a) Underscore the main points or make a marginal note of them. (b) Give special attention to italicized words. (c) Learn the meaning of technical words, as atom, electron, etc. (d) Build a vocabulary of chemical words for quizzing purposes. (e) Master a paragraph before proceeding to the next one.

Question Yourself on the Contents:

Go back, and after looking at the paragraph heading try to recall its essential facts or check your accomplishment by the "Self-testing Questions." Repeated

recitation is a more effective method of remembering than merely reading the assignment over and over again.

Prepare for Tests:

Make up questions (preferably completion type) covering the main points and those other points which you would bring up were you the instructor. Sometimes it is an advantage to be quizzed by another student. The next best practice is to answer the author's questions.

Study Plans:

(a) Go over your assignment or lecture notes *the day they are given*. This enables one to remember and plan for study time. (b) Study the assignment *the day before going to class*. (c) Review underscored lines, italicized words, and your notes the next morning, or *just before going to class*.

IV. IMPROVING YOUR MEMORY

Everyone spends hours trying to remember things. Maybe it's a name, some statement you read, or something you were supposed to do. You try to concentrate, to pull the thought out of the recesses of your mind. But there are no real muscles that you can use to draw a memory from the past. The harder you try to remember in that manner, the more likely you are to forget. To illustrate, suppose that when being introduced to someone, you are aware of the blue color of his suit, his red necktie, and his mustache. Later, in trying to remember his name, you think of these details and what happens? You cannot recall it. Why? Because your mind is crowded with these details that only serve to detract from the name you want to remember. There has been no association between the man and the name.

Association Aids Remembering:

Instead of this haphazard method, make these details help you. Immediately following the introduction, begin to tie them all together by associating them with something definite about the person. They will have a tendency to stay together. Then, when one fact comes into your mind, they are automatically all brought to the surface. If the man's name in the above incident was Skye, for example, it would be a simple matter to associate the name Skye with the blue color of his suit by merely associating blue and Skye. Blue Skye. It sounds silly, but it does aid remembering. In this simple plan for remembering, you have pictured a detail you wish to recall. Mind pictures are more easily remembered than anything else. To recall anything, you must first give sufficient attention to the facts you wish to remember; and second, learn as many related facts and ideas as you can, so that any one will recall all the others.

How to Retain What You Read and Study:

Sometimes you find after reading a page, your text for example, the inability to recall a single line. The usual reason is that you have read too rapidly, skipped words here and there, let your mind wander occasionally about some-

thing else, or maybe were not in the right frame of mind, worried for instance. To overcome one or more of these bad reading habits, especially lack of concentration, and be able to retain, text book material for example, you must:

First. Learn to read *slowly*, only one thing at a time (no skipping), and keep your mind on the understanding of each sentence before passing onto the next sentence. By reading slowly your mind's eye can coordinate with your visual eye, and then you will have a mental moving picture of what ideas the author is presenting, a principle long ago presented when the Chinese stated that "One picture is worth a thousand words." To retain what you wish to remember you must use a mental moving picture of what you want to remember and *associate* it with something that is already present in your mind.

Second. Underscore the main points or make a marginal note of them.

Third. Check your retention by raising your eyes at intervals from your reading and find out how much you can recall. If unable to make a rapid mental moving picture, a glance back at the reading will let you know how well you are concentrating and retaining the subject matter. And for emphasis, again you must understand and master a paragraph before proceeding to the next one; for if you cannot remember at this point in your reading, what chance do you think you will have of remembering in a coming recitation or written test?

Fourth. Frequently glance back over the main points, and at future times acquire the habit of reviewing. Interval reviewing to memorize requires about one-half the time as does one reading.

Sometimes You Forget in Order to Remember:

However, if, after really learning something, you still cannot recall it, try hard to forget it, the secret of accomplishment being to expel it by substituting a more powerful thought. Clear your mind of what is blocking it, and keep it cleared.

Sometimes you will make an intense effort to quickly recall something, and succeed in doing it. But the next time you will find it harder to recall. You may even be unable to recall it at all. This is due to overloading your mind with unrelated details.

When the trick of forgetting unrelated details becomes part of your memory method, you will amaze yourself with the variety of things you can recall. Your very efforts thus far have hidden them from view. If you can't recall something at once, leave it alone, do something else so you will forget it. Later, try a second time. If that doesn't work, start forgetting again. Once this becomes a habit, you will have no difficulty in recalling instantly almost anything you once learned.

There Are Three Laws of Memory:

INTEREST is the first of three great laws of memory. You can learn anything that you are sufficiently interested in. Since learning is necessary for remembering, the deeper the interest, the more readily you can remember.

The student who can't learn chemistry or any other subject is not very much interested in it. Chances are very little will be remembered unless interest is aroused.

SELECTION is the second great law of memory. If you did not forget almost everything, you could not remember anything. Of the countless impressions received by your mind every hour, it is necessary to retain only a select few. Otherwise your mind would constantly be in a state of chaos. Building up a strong memory does not mean remembering everything.

ORGANIZATION is the third and most important law of memory. You must center your knowledge around one definite goal, nursing, for example, and keep it in mind always.

From this we can see how all three laws—interest, selection, and organization—depend upon each other, and must work together to give you knowledge and a strong memory.

Immediate Reviewing Saves Hours of Study:

Acquiring the habit of review is of major importance in improving your memory. When reviewing anything you want to remember, do it at once, the same day. Otherwise, you will spend two or three times as long the next day. Re-read it a day later, and, after a week, a quick glance at it will suffice to refresh your memory.

As a matter of future consolation, your memory does not become dim with age. It takes you longer to organize your thoughts but your mental power is the same.

INTRODUCTORY NOTES

TO THE INSTRUCTOR

IT MAY be helpful to offer, briefly, what has been found to be a very satisfactory method of presenting the subject of Chemistry to student nurses. The nature of the work expected, and some of the things required of the student, may be presented to the students as a preliminary to beginning the study of chemistry. It is *not* advisable, however, to reveal all that will be expected of the chemistry student, any more than it would be to try to tell a child all that life expects of him. Many things should be presented gradually, and as the work progresses, otherwise the student may become confused and discouraged.

CLASS WORK

(1) **THE TEXTBOOK:** A textbook is an educational tool. No attempt should be made to use such a tool until the student becomes familiar with it. Explain the organization of the book, beginning with the table of contents. Show the principal divisions of the text and their nature. Now examine one of the chapters showing its organization, its preliminary material, its lesson plan, and its study aids at the end of the chapter.

The first division of this text, *Inorganic Chemistry*, takes up some of the accomplishments of chemistry in providing for greater health, comfort, and leisure. It gives (1) a somewhat elementary conception of the meaning of chemistry, (2) some idea of the accomplishments of the chemist in a changing civilization, (3) an understanding of the chemist's working terms, (4) a mental conception of the electrical nature of the atom and its behavior in chemical changes, (5) a knowledge of the properties and uses of oxygen, water, acids, bases, salts, and certain nonmetallic elements, and (6) the behavior of these elements or compounds under varying conditions.

The second division of this text, *Organic Chemistry*, stresses concentration on certain type reactions applicable to each of the homologous series mentioned. The type equations, together with the examples which accompany them, illustrate the chemistry of other members of the series. In this way students become familiar with the characteristic properties of each series, and do not have to learn too many equations other than the type equations.

The third division of this text, *Biochemistry*, aims only to give students the essential background and facts necessary to understand and evaluate any future accomplishments in this field of work.

This text is designed to enable students to study without any interpretation on the part of the instructor, thereby stimulating the student's interest. Human interest is one of the major principles of education, and without it one remains a poor student.

Interest is the essence of scientific thinking. Teaching difficulties, as usually met, are made somewhat easier by introducing practical helps for both student and instructor.

The outline at the beginning of each chapter simplifies and classifies the subject matter.

The "self-testing" questions at the end of the natural breaks in each chapter are such that when properly answered they will assure the student that the minimum essentials have been mastered. The "thought-provoking" questions in the Suggested Activities are primarily for those students who can think in the realm of chemistry. These questions are mostly of a practical nature, and have been asked with a view not only of fixing the basic facts developed in the text, but also to enable the student to solve future problems based upon these principles. Since the answers are not directly stated, these thought-provoking questions should develop individual thought and research on the part of the student. To provide further for individual differences and to facilitate individual work there are special *topics* and *suggestions*.

The important technical words or terms as they first appear in the discussion are listed at the end of each chapter under the title, "vocabulary testing of new terms." This list will be helpful to students who have formed the habit of looking up words that are not familiar to them.

The "topics for oral or written reports" are primarily for students who are capable of doing additional work, especially for those who have had a year's work in elementary chemistry. The reference books and periodicals listed on page 629 should prove helpful as sources of material for such reports. These references, and others, are to be found in most science libraries.

The suggestions for "display posters, charts, or exhibits" may be used to present in a brief and concise form the main points of the subject studied. It is often advisable to allow the student to make a suggestion for a poster. A general exhibit at the end of the semester is well worth while both to the student and the instructor.

In this connection, interest in the course will be aroused by asking the pupils to present any clippings from current periodicals of a chemical nature. These should be signed by the donor and attached to the Chemistry Bulletin Board.

The illustrations, far in excess of those in other texts of this nature, have been selected with a view to stimulate interest and motivate thinking. In this way chemical principles and their applications are visualized by the student, thus adding to the clarity of text explanations.

From the above statements it should be evident that the text has been organized not only to aid the student, but also to assist the instructor in his teaching problems.

(2) **ASSIGNMENT:** Go over the Preview and the main points of the Chapter Outline of an assignment, emphasizing important parts, pointing out difficulties, and showing some of the practical applications.

(3) **TESTS:** Tests are conducive to study-habit formation. Have ready two mimeographed sheets, A and B, each containing a dozen or more questions of the one-word answer, the multiple-choice, or the matching-answer type. The tests should review the past class and laboratory work, and cover also the assignments of the day or week. Following the assignment, and previous to the lecture-recitation, give every alternate student the same set of questions. It will be evident that these tests will be a check of the student's review work, and the preparation for the advance assignment. Further checking is made possible by mid-semester and term examinations. After collecting the papers, immediately review the tests.

(4) **LECTURE, RECITATION, AND DEMONSTRATION:** Follow up the review of the tests by discussion of further points brought up in the assignment for the day or week. This may consist of lecture, informal questions, or discussion by the students. Lecture, accompanied by demonstrations and recitations, is an effective method for class work. The extent to which each of these different procedures is used will depend upon the lecturer and the size of the class, as well as the preparation and previous experience of the students.

STUDY ASSIGNMENTS

Since textbook assignments depend upon the number of hours allotted to the course, and the previous training of entering students, the following assignments are suggested:

(1) For a *short course*, with all of the students having been carefully selected, the first seventeen chapters offer sufficient material for two hours of lecture-recitation and one laboratory period per week. This will constitute a sixty-hour course.

(2) For a *short course* when the time allotted for the course is the same as in (1), but when all of the students have had the equivalent of a *good* course in high school or college chemistry, practically the entire text can be covered. This can be accomplished by reviewing the discussion part of the first eleven chapters (Inorganic) and selected parts of the laboratory exercises in the recitations and the laboratory assignments. Such a rearrangement will then allow these students extra class and laboratory periods for covering the organic section, and selected portions of the biological section. If pressed for time, the chapter on Blood and Lymph and the chapter on Hormones may be omitted as these subjects are treated in physiology. Also the chapter on Vitamins and Milk can be considered in nutrition. This then will constitute a sixty-hour course.

(3) For a *long course* there is sufficient material in the twenty-two chapters to cover one semester's work by assigning individual chapters, including the "Suggested Activities." Such a course will be suitable to schools of nursing which are affiliated with universities. It will constitute a ninety-hour course.

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