

- 全国高等医药院校药学类实验双语教材
- 教育部普通高等教育“十一五”国家级规划教材

(第二版)

无机化学 实验与指导

EXPERIMENT AND GUIDE
FOR INORGANIC CHEMISTRY
(2ND EDITION)

主编 曹凤歧

中国医药科技出版社

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内 容 提 要

本书是根据高等医药院校药学类专业无机化学实验课程的教学基本要求,并融合无机化学实验教学改革成果编写的无机化学实验教材。全书共包括二部分,第一部分扼要地叙述了无机化学实验的基本原理和基本操作;第二部分,按照“基础性实验-综合性实验-设计性实验”三个层次,选编了23个实验,在每个基础性实验和综合性实验之后,编写了实验指导,内容包括预习要求、操作要求、注意事项、思考题和讨论。23个实验全部采用中英文对照,便于双语教学。

本书可作为高等院校药学类各专业的无机化学实验教材。

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编写说明

经教育部和全国高等医学教育学会批准，全国高等医学教育学会药学教育研究会于2004年4月正式成立，全国高等医药院校药学类规划教材编委会归属于药学教育研究会。为适应我国高等医药教育的改革和发展、满足市场竞争和医药管理体制对药学教育的要求，教材编委会组织编写了“全国高等医药院校药学类规划教材”。

本系列教材是在充分向各医药院校调研、总结归纳当前药学教育迫切需要补充一些教学内容的基础上提出编写宗旨的。本系列教材的编写宗旨是：药学特色鲜明、具有前瞻性、能体现现代医药科技水平的高质量的药学教材。也希望通过教材的编写帮助各院校培养和推出一批优秀的中青年业务骨干，促进药学院校之间的校际间的业务交流。

参加本系列教材的编写单位有：中国药科大学、沈阳药科大学、北京大学药学院、广东药学院、四川大学华西药学院、山西医科大学、华中科技大学同济药学院、复旦大学药学院、西安交通大学药学院、山东大学药学院、浙江大学药学院、北京中医药大学等几十所药学院校。

教材的编写尚存在一些不足，请各院校师生提出指正。

全国高等医药院校药学类

规划教材编写办公室

2004年4月16日

序

实验教学是高等药学院校最基本的教学形式之一,对培养学生科学的思维与方法、创新意识与能力,全面推进素质教育有着重要的作用。飞速发展的科学技术,已成为主导社会进步的重要因素。高等药学院校必须不断更新教学内容,以学科发展的前沿知识充实实验课程内容。

近年来,中国药科大学坚持以研究促教改,通过承担教育部“世行贷款——21世纪初高等教育教学改革项目”及立项校内教改课题等多种方式,调动了广大教师投身教学改革的积极性,将转变教师的教育思想观念与教学内容、教学方法的改革紧密结合起来,取得了实效。此次推出的国家“十一五”规划教材——药学专业双语实验教学系列,是广大教师长期钻研实验课程教学体系,改革教学内容,实现教育创新的重要成果。他们站在21世纪教育、科技和社会发展趋势的高度,对药学专业实验课程的教学内容进行了“精选”、“整合”和“创新”,强调对学生的动手能力、创新思维、科学素养等综合素质的全面培养。这套教材具有以下的特点:

1. 教材将各学科的实验内容进行了广泛的“精选”,既体现了高等药学教育“面向世界、面向未来、面向现代化”,也考虑到我国药学教育的现状与实际;既体现了各门实验课程自身的独立性、系统性和科学性,又充分考虑到各门实验课程之间的联系与衔接,有助于学生在教学大纲规定的实验教学学时内掌握基本操作技术,提高动手能力,养成严谨、求实、创新的科学态度。

2. 教材中新增的综合性、设计性实验有利于学生全面了解和综合掌握本门实验课程的教学内容。这一举措既满足了学生个性发展的需要,更注重培养学生分析问题、解决问题的能力 and 创新意识。

3. 教材中适当安排一些反映药学科发展前沿的实验,有利于学生在掌握实验基本技术的同时,对药学科的新进展、新技术有所了解,激发他们学习药学知识与相关学科的兴趣。

4. 教材以实践教学为突破口,采用双语体系编写,为实验课程改革构建数字化、信息化和外语教学的平台,有利于提高学生的科技英语水平。通过我校多年的药学系列实验课程双语教学实践,证明学生完全能够接受此套教材的教学。

国家十一五规划教材——药学专业双语实验教学系列教材的陆续出版，必将对推动我国高等药学教育的健康发展，产生积极而深远的影响。由于采用双语体系编写药学教学实验丛书尚属首次，缺乏经验，在内容选择及编写方法上的不妥之处，在所难免。欢迎从事药学教育的同行们批评赐教。

吴晓明

(中国药科大学校长、博士、教授、博士生导师)

Preface

Experimental teaching is one of the most fundamental teaching means in pharmaceutical colleges, playing an important role in training scientific thoughts and methods, creative consciousness and ability of the students as well as in promoting quality-oriented education in all-round way. Fast-advancing science and technology has come to be an important factor in dominating social progress. Teaching materials must be updated continually in pharmaceutical colleges, especially enriching the materials of experimental courses with the most advanced knowledge in the subject.

In recent years, China Pharmaceutical University have been stressing the promotion of teaching reform on the basis of research, succeeding in stimulating teachers' enthusiasm for teaching reform by various means such as undertaking the project of teaching reform in higher education at the beginning of 21st century sponsored financially by World Bank and entrusted by the Ministry of Education as well as approving and ratifying internal programs on teaching reform. Meanwhile, it yields fruits to integrate the transforming of teachers' educational ideology into the reform of teaching materials and methods. This series of textbook of national "11th five" planning-bilingual pharmaceutical experimental teaching series, is an important achievement made through studying teaching system of experimental courses for long, reforming teaching materials and carrying out educational innovation of all the teachers concerned.

Meeting the new demands for education, science and technology and social growth, they select, integrate and innovate the teaching materials of pharmaceutical experimental courses, stressing the overall cultivation of comprehensive qualities, including experimental ability, creative thought and scientific attainments. This set of textbook possesses the following features:

1. These textbooks make an extensive "selection" of the experimental materials of each subject, reflecting the goal of facing the world, facing the future and facing the modernization in higher pharmaceutical education, and taking into account the status quota and reality of our pharmaceutical education; meanwhile embodying the individuality, systematicness and scientificness of each experimental courses, which helps the students to grasp basic techniques of operation within the class hours of experimental teaching pre-

scribed by teaching syllabus and to improve their experimental ability and finally to cultivate a scientific approach of precision, practicality and creation.

2. The comprehensive designing experiments newly supplemented in the textbooks help the students to learn totally and grasp comprehensively the teaching materials of the experimental courses, which not only meets the students' needs for individual development but also trains their ability to analyze and solve problems and cultivates their creative consciousness.

3. Some experiments representing the latest development in pharmacy are properly included in the textbooks, which helps the students to learn about new advance and technology in pharmacy and to further arouse their interests in studying pharmacy and relevant subjects while grasping some basic techniques of experiment.

4. The textbooks take experimental teaching as starting point and are compiled in a system of bilingualism and aim to set up a platform of digitalization, information and foreign language teaching for the purpose of reforming experimental courses, which serves to enhance the students' level of technological English. It has been proved that the students have no difficulty being adapted to the teaching of this set of textbook through many years of bilingual teaching practice carried out in a series of pharmaceutical experimental courses of our university.

The successive publishing of the series of textbooks used for bilingual pharmaceutical experimental teaching-the national "11th-five" planning textbooks, will surely produce good and far-reaching influence in promoting the sound development of higher pharmaceutical education of our country. Since it is the first time that we have compiled this series of textbook of pharmaceutical teaching experiment in a bilingual system, we lack experience and thus some defects in choice of materials and way of compilation are inevitable. Experts engaged in pharmaceutical education are welcome to give any criticisms and advice.

Wu Xiaoming

Ph. D, prof., and supervisor of doctoral candidates
President of China Pharmaceutical University

第二版前言

《无机化学实验与指导》双语教材第一版 2003 年由中国医药科技出版社出版以来,受到国内许多兄弟院校化学教师的重视。并被全国许多院校的学生采用,他们发现的不妥之处以及改进的意见等以通信的方式或在有关的教学研讨会上与编者进行了交流、探讨。对关心这本教材,提出宝贵意见的教师和学生,编者表示由衷的感谢。

本次修订的原则是:全书内容及编排体系基本不变,主要对一版的不妥和错误之处进行修订。

有关书中实验的安排由老师事先通知,以使学生对每个实验有充分的预习。本书中的实验内容与教师在课堂上讲授的内容不会完全相协调,因为我们的目的是要通过实验发现某些化学原理。若这些原理在课堂上讲过了,学生对实验的兴趣将会大大降低。

修订稿承蒙中国药科大学王越博士审阅,并提出宝贵的意见和建议。对此,编者衷心欢迎读者对书中欠妥之处提出批评指正。

曹凤歧

2006 年 8 月

Preface to the Second Edition

Fengqi Cao

(Nanjing, August 2006)

The first edition of bilingual textbook "The Experiment and Guidance of Inorganic Chemistry" has been greatly valued by chemistry teachers in many domestic universities and colleges since its publication by China Medical Science and Technology Press in 2003. The textbook has been in use among many universities. Some inappropriate places in the textbook and some suggestions on the improvement of the book from the teachers and students have been discussed and exchanged with the compiler either by correspondence or at the teaching research meeting. The compiler will show his hearty appreciation to both the teachers and the students who offer their good advice on the textbook.

The principle of this revision is that the contents and the compiling arrangements of this book are not changed basically, and some inappropriate places and mistakes are revised mainly.

The arrangements of experiments in the textbook are hinted by the teachers beforehand so as to make the students well-prepared for each experiment. The experiment content in the textbook is not coherent absolutely with the teachers' content in class, because we aim to let the students discover some chemical principles through the experiments. If these principles are taught in class, the students' interest in the experiments will be reduced greatly.

It is very kind and grateful of Doctor Wang Yue from China Pharmaceutical University to go over the second edition and to give some helpful advice and suggestions. It is here that the compiler will heartily welcome the reading public to point out some mistakes and faults in the textbook.

第一版前言

化学就其本源和本质而言是一门实验科学。在任何时期,新的理论的发现和检验,都要通过实验。化学实验教学是化学教学过程中的重要环节。

通过实验中的操作训练,学生能够在了解和使用仪器设备、信息工具与手段的同时,逐步养成认真细致、求实求精、有条不紊的学习习惯;通过对实验现象的观察,不断提高观察问题、分析问题、发现问题、解决问题的能力。因此,化学实验教学对学生科学思维与方法的培养、创新意识与能力的提高有着重要的作用。

本书是编者在总结多年无机化学实验教学改革、双语教学实践的基础上,借鉴和吸收其他高校在无机化学实验教学改革的经验编写而成的。本教材立足于课程的基础性,扼要地叙述了无机化学实验的基本原理和基本操作;并从药学学科的特点出发,分三章选编了23个实验。第四章包括以强化基本能力训练为目的的基础性实验;第五章包括以培养分析与解决较复杂问题能力为目的的综合性实验;第六章包括以增强创新意识与能力的提高为目的的设计性实验。另外,本教材在每个基础性实验和综合性实验之后,编写了实验指导,内容包括预习要求、操作要求、注意事项等。

为了提高学生的英语水平,适应双语教学的要求,我们将23个无机化学实验全部翻译成英文。

本教材由曹凤歧主编。编写人员有王越、熊晔蓉、黎红梅、陈亚东、李嘉宾、何海军、曹凤歧。陈颂仪、刘静、陆军农也参加了部分工作。

在我们的教学、科研及本教材的编写过程中,一直得到中国药科大学校长吴晓明教授、教务处处长姚文兵教授的支持和帮助。Wei Song 博士和 Lian-shan Zhang 博士对英文的编写工作提出过许多宝贵的意见,在此一并表示衷心的感谢。

尽管在本教材的编写过程中,我们力求做到选材恰当,翻译准确,但由于编者学识水平有限,教材中定有欠妥甚至错误之处,恳请同行专家及读者批评指正。

曹凤歧

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Preface to the First Edition

Fengqi Cao

(Nanjing, December 2002)

In terms of its origin and nature, chemistry is a science of experiment. At any time, theoretical discoveries and tests have to go through experiments. Chemistry experiment teaching is a key link in the process of chemistry teaching.

Through operation training in experiment, students are able to understand and use apparatuses, tools and means of information, students will gradually cultivate a good study habit of working carefully, methodically, practically and improving constantly. By observation of experiment phenomena, students will be able to improve their abilities in examining, analyzing and solving problems. Therefore, experiment teaching of inorganic chemistry plays an important role in training students' thinking scientifically and methodically as well as in improving their sense and ability of blazing new trails.

Based on the summary of the reform in experiment teaching of inorganic chemistry as well as bilingual teaching of this course in both Chinese and English in recent years, by using the experiences of the reform in experiment teaching of inorganic chemistry in other colleges and universities for reference, we have compiled this book, which focuses on the foundation and briefly describes the basic operations and principles of experiments in inorganic chemistry. 23 experiments have been selected in Chapters 4, 5 and 6 in accordance with the features of courses in chemistry. Chapter 4 is on the training of basic experiments to intensify students' basic experiment skills. Chapter 5 is on comprehensive experiments to train students' abilities in analyzing and solving complicated problems. Chapter 6 is on designing experiments to improve students' sense and ability of blazing new trails. Besides, after each of the basic and comprehensive experiments, we have compiled the following: (1) preview experiments; (2) operation instructions; (3) points for attention.

In order to improve students' level of technological English and meet the demands of bilingual teaching in both Chinese and English, we have translated the 23 experiments into English.

The chief compiler is Fengqi Cao. Following are the compilers: Yue Wang,

Yerong Xiong, Hongmei Li, Yadong Chen, Jiabin Li, Haijun He and Fengqi Cao. Besides, Songyi Chen, Jing Liu and Junnong Lu also took part in the compiling work partially.

When compiling this textbook, we were greatly supported and helped by Professor Xiaoming Wu, President of China Pharmaceutical University; Professor Wenbing Yao, head of the Dean Office, Dr Wei Song and Dr Liaoshen Zhang gave us invaluable pieces of advice. We therefore express our sincere thanks to them for their great help.

In compiling this textbook, we have tried our best to select suitable materials and provide the users with a fine English version of the 23 experiments. However, there might still exist something improper or even erroneous due to our academic limitations. We would be most appreciative if anyone could give us further suggestions on improving this textbook.