



中国科学院教材建设专家委员会规划教材
全国高等医药院校规划教材

PATHOPHYSIOLOGY EXPERIMENT

病理生理学实验

(英文版)

Chief Editors Rong Xing (邢嵘)

Caihua Zhang (张彩华)



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内 容 简 介

本书为病理生理学实验的英文教材。全书共分为五部分,包括概述、病理生理学实验的基本知识和基本操作、病理生理学经典的动物实验及探索性试验、设计性实验和典型病例,这些内容紧紧围绕病理生理学理论知识,对促进理论知识的学习起着重要的辅助作用。该教材内容翔实,知识系统,写作流畅,图文兼有,不但是留学生病理生理学实验教学优选的教材,也可以作为国内各类医学院校相关专业的教师、学生的参考用书。

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序

病理生理学是一门以患病机体为研究对象，研究疾病发生发展和转归规律的学科，它的任务是揭示疾病的本质，为临床诊断和治疗疾病提供理论基础和实验依据。在医学教育中，病理生理学是基础医学的主干课程，也是沟通基础医学和临床医学的“桥梁”课程。

近年来，随着我国经济、科技和教育事业的快速发展，病理生理学在注重理论教学的同时，对实验教学也很重视；而且，不断引入医学教育国际标准，同时积极发展留学生教育已成为我国高等教育发展的必然趋势。因此，一本内容丰富、与时俱进、操作性强的英文版病理生理学实验教材是非常需要的。邢嵘、张彩华主编的英文 *Pathophysiology Experiment* 适时出版，正好符合了这一需求。

本书在内容的选择、章节的安排上颇具特色。其中的病理生理学基本理论和基本操作的介绍将为学生学习奠定良好的理论和实践基础；经典病理生理学实验将训练和提高学生的实验技能和动手能力，培养学生团结协作的科学作风，同时促进学生对理论知识的理解和记忆；设计性实验部分能充分调动学生的主动思考、分析问题、解决问题的能力，培养学生的创新精神；最后部分的典型病例分析，有助于学生将抽象的医学理论感性化，提高学生的学习兴趣，充分发挥学生的主观能动性，进而启迪学生的临床思维和培养学以致用能力。因此，这本书内容全面、简洁实用、指导性强，对中国学生提高专业英语水平以及对留学生实验教学的顺利进行都具有重要的参考价值。

最后，衷心祝贺本书的出版，并热忱地向兄弟院校的病理生理学教学工作者推荐本书，希望它能在促进我国医学国际化教育的发展中发挥良好的作用。

同济大学

李永渝

2015年4月8日

Foreword

Pathophysiology studies the underlying mechanisms of occurrence, progression and outcome of diseases. In addition to uncover the nature of diseases, pathophysiology provides fundamental theories and experimental evidences for establishment of appropriate diagnosis and treatments of diseases. In medical education, pathophysiology is the main course bridging basic and clinical medicine.

With rapid progresses made in China, it is good time to emphasize courses on pathophysiological experiments no less than its theories. Besides, introduction of international standards into medical education and vigorous development of medical school education for international students demand an up-to-date and feasible pathophysiological experimental textbook of English edition. Therefore, publication of English edition *Pathophysiology Experiment* edited by Rong Xing and Caihua Zhang is a welcome addition.

The book is truly prominent in choosing the contents and their arrangements. For example, the part on basics of pathophysiological knowledge and operation techniques provides students a sound basis first. The part on classical pathophysiological experiments will not only train or even improve the experimental skills of students', but also promote teamwork and facilitate students' understanding and memorizing of theories; moreover, the designing experiments could certainly inspire their active thinking, analyzing and resolving problems. The last part on typical case analysis will help the students perceiving and applying the pathophysiological knowledge. Step by step, students should be benefited in their ability to think logically, which should help them later on for clinical case analysis. Thus, this concise and easy-to-follow book is important for Chinese students who want to improve professional English or for international students who is studying pathophysiology.

At last, sincere congratulations on publication of this book and it is strongly recommended to the pathophysiological staff in fraternal colleges. This book should be suitable for international medical students.

Tongji University School of Medicine

Yongyu Li

April 8, 2015

前 言

医学留学生教育已成为我国高等医学教育的重要组成部分，提高留学生的教学质量，适应国际化高素质人才的培养目标，是推进教育国际化、深化留学生教育综合改革的要求。本教研室近些年来在改革留学生实验教学方面进行了大量的探索和实践，对传统的病理生理学实验教学模式进行了突破性的创新设置，形成了具有本教研室特色的病理生理学实验教学课程体系，此项改革已在省教育厅和中国高教学会外国留学生教育管理分会立项。

医学教育中实验教学是重要的环节，通过实验教学加强对理论知识的理解和掌握、训练学生的科学思维方式、提高动手能力、培养创新性高素质人才。病理生理学是基础医学中理论性很强的一门学科，也具有很强的实践性，在病理生理学理论的形成过程中，通过动物实验、临床观察和疾病的流行病学研究等手段探索疾病发生发展的规律和机制。开设病理生理学实验课的目的是通过具体操作，提高动手能力，通过实验结果的观察与分析，培养独立思考和解决问题的综合能力，因此编写适合留学生的实验教材是实验教学的需要，是学生上好实验课的基础。本教研室结合多年留学生实验教学的积淀，组织具有一定教学经验、热情十足和娴熟外语水平的教师参与编写这部实验教材。该教材以本教研室开展的适合留学生学习特点的病理生理学实验教学新模式为蓝本，共分为五部分，包括概述、病理生理学实验的基本知识和基本操作、病理生理学教学经典的动物实验、设计性实验和典型病例，是一部内容翔实、知识系统、极具实用性的教材。

本教材的编写得到了学校国际教育学院和基础医学院等部门的大力支持，也得到了许多资深专家的指点和帮助。在编写本书的过程中，编者本着认真负责的态度，精心斟酌每一句词语、每一个词汇，力求做到准确、简明。但鉴于这是本教研室第一次独立编写留学生实验教材，以及编者本身的水平有限，难免会出现错误和不足，我们真诚期待广大学生及同仁给予批评指正。

大连医科大学

邢 嵘 张彩华

2015年1月

Preface

Medical international student education has been a consideration part of high medical education in our country. It becomes a requests of facilitating education internationalization, deepening integration reform in international student education to improve teaching quality and cultivate high-quality students that adapt to the internationalization. Our staff have explored and practiced in international student experiment education. We have brought new ideas in traditional pathophysiology experiment teaching and formed idiomatical pathophysiology experiment teaching curriculum system. This project has been set up in the Department of Education in Liaoning province and in Foreign Student Education Management Branch of China Association of Higher Education.

Experiment education, which can reinforce and master the theory, train the students' scientific thinking mode, improve the practical ability and cultivate innovative talents , is the important element in medical education. Pathophysiology is a subject with strong theory and practice. It is the way of exploring the pathogenesis of disease through the animal experiment, clinical observation and epidemiological research during the formation of pathophysiology theory. pathophysiology experiment course aims to improve the practical ability through the specific operation, cultivate the comprehensive ability of independent thinking and problem solving through observation and analysis of the results of the experiment, so it is the need and basis of experiment teaching to compile experimental teaching materials for international students. We organize those teachers with teaching experience, enthusiastic and skilled foreign language to participate in the preparation of this textbook. This book is based on new experiment teaching mode that suitable for learning characteristics of the foreign students. There are five parts in this textbook, including outline, basic knowledge and basic operation of pathophysiology, classical animal experiment, designing experiment and typical cases. It is an informative, comprehensive knowledge, highly practical teaching material.

This textbook has gained support from the International Education College and Basic Medical College, etc., we also get many senior expert guidance and help. Although we strive to achieve accurate and concise in the process of writing the book, there could be some mistakes and shortcomings, we sincerely look forward to the criticism from vast number of students and colleagues.

Dalian Medical University
Rong Xing Caihua Zhang
January, 2015

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Chapter 1 GENERAL INTRODUCTION

I . Characterization of pathophysiological experiments

Pathophysiology is a subject to explore the rule of origin and evolution of disease processes and underlying mechanism. It focuses on the functional and metabolic alterations and mechanisms underlying the development of diseases, providing theoretical basis for diagnosis, prevention and treatment of diseases.

Scientific experiment is an important part of the pathophysiological contents of courses. The useful approaches include (acute and chronic) animal experiments and clinical explores. The acute animal experiments and the classroom discussion of classic cases are the major methods and are suitable for experimental classroom teaching within a limited time.

Reproducing human disease via animal model: Duplication limited representative human diseases or pathologic process at the selected experimental animal body under the carefully designed are served as the model for related human disease. The typical copied animal model might represent the changes of the human disease development. Researchers may purposely control or alter certain conditions to explore etiologies, pathogenetic rules and mechanisms of various pathological alterations. The techniques used in pathophysiology study room are still mainly limited in systemic or organic levels, and focus on the functional and metabolic alterations.

II . Contents of pathophysiological experiments

1. Basic knowledge and basic operations of pathophysiological experiments

Introduce the nature, characteristics and requirements of pathophysiological experimental courses. Introduce the laboratory equipment and experimental animals, explain and train the popular animal experiment operation technology, the principle and method of experimental design.

2. Classical teaching animal experiment of pathophysiology

There are many animal experiments in pathophysiology. By choosing eight classical and representative projects, the students can familiar with experimental process, master some scientific experiment skills and depth on the theory knowledge understanding.

3. Design experiment

In the designed experiment, we give “experiment goal” and “experiment request” briefly, require students refer information and design project after class. Then comment on the result through the opening report way.

4. Typical cases

Under the analysis of several typical clinical cases, students can propose their own idea and solution by combining the theoretical knowledge and the actual situation, meanwhile, they can

further understand the bridge role of pathophysiology between basic and clinical sciences, master pathophysiology knowledge

III. The aim of pathophysiological experiments

(1) Grossly master the basic methods of duplicating acute animal model for human diseases and master the basic operating techniques of pathophysiological experiments.

(2) To cultivate abilities of students to analyze and solve problems through discussing the experimental results.

(3) To strengthen the training of the students' thesis writing through writing experimental report.

(4) By designing experiments, to inspire the student's passion to learn, and to cultivate their creativity and consciousness of scientific research.

(5) To develop the students' ability to analyze clinical cases and to lay the foundation of clinical thinking and strategic decision through the discussion of clinical cases.

IV. The requests of pathophysiological experiments

1. Prior to the experiment

Students should read the experimental guidance carefully, understand the aim and request of the experiment, and then learn its principle and grasp its method. They also need to review the theory by combining the content of the experiment to understand it thoroughly and predict the result of every step in the experiment as well as possible. After group discussion, arrange the division of labor.

2. During the experiment

First, get animals on time and check equipment and drugs carefully. Second, know the correct method of how to use equipment, examine their function and debug them. Third, operate as the step says and accurately estimate the quantity of drugs that should be used. Then observe phenomena in the process of the experiment carefully and write down primary record following the principle of object and reality at any time. At last, participate in the discussion of experimental contents actively. It should be noted that team members should assist each other, care instruments, save chemical, material, keep clean, safe laboratory.

3. After the experiment

Students should properly disposed carcasses and clean the experiment equipment and laboratory. They should fill the record in the experimental reports in which describe the results objectively and come up with conclusion of the experiment by analyzing. The reports should be succinct, fluent and clear and they must be handed in to teachers on time.

V. Writing requests of pathophysiology experimental report

Writing an experimental report is an important basic skill and is the basis of thesis writing. The requests of experimental report should include the integral description for the whole experimental process, the real data, scientific analysis to experimental results, reflection of

mistakes and making comments and suggestions for the deficiency of experimental design. Write carefully as requirements say. Notice the concision of words, fluency, distinctness and tidiness, and use punctuation mark correctly.

The contents of a report are as follows:

- (1) Roll number, name, class, group, date, guide teacher.
- (2) Serial number and title of the experiment.
- (3) The aim of the experiment.
- (4) Object of the experiment noting weight and general state.
- (5) Drug and equipment of the experiment: State major drugs and equipments of the experiment briefly.
- (6) Steps of experiment: Name, dosage and way of injection are completely. If equipment and method of the experiment are alternated temporarily or reliability of observation is affected account of operating skill, brief explanation is needed.

(7) Experimental result: It is one of the most important parts in the experiment. Students should set down the phenomena they have observed fit actuality accurately and in detail. Primary record should be done whenever observing. After the experiment, arrange according to the record and show it in different ways. Don't only depend on memory or redirect record as one please. The treatment on results can refer to the requirements above.

(8) Discussion and conclusion: Discussion of the result is to explain and infer from the result and phenomena with theoretical knowledge that are learned. Judge whether the result is prospective is necessary. If result which isn't prospective happens, students should analyze the possible reasons. The conclusion of the experiment is a kind of common and summary judgment that sums up from the result, namely the concept, principle or theoretical brief summary that verified by the experiment. Don't list concrete result in conclusion. Theory and analysis that don't have enough evidence should not be written into conclusion.

Discussion and conclusion of the experiment are creative work. They can show students' abilities of analyzing and solving problems. Students should be serious and not copy books blindly. If referring to outside reading, students should note reference.

Here is the common form of experimental report:

Pathophysiology Experimental Report

Class: _____ Roll number: _____ Name: _____
 Group: _____ Date: _____ Guide teacher: _____
 Serial number and title of the experiment:

Aim of the experiment:

Object of the experiment:

Drug and equipment of the experiment:

Experimental steps:

Experimental result:

Experimental discussion:

Experimental conclusion:

References:

(Rong Xing Caihua Zhang)

Chapter 2 BASIC KNOWLEDGE AND BASIC OPERATIONS OF PATHOPHYSIOLOGY EXPERIMENTS

Section 1 COMMON APPARATUS USED IN PATHOPHYSIOLOGICAL EXPERIMENTS

I . BL-420 Biological data acquisition and analysis system

BL-420 (or BL-410) Biological data acquisition and analysis system purchased from Chengdu Technology & Market Co, Ltd., is suitable for the physiological experiments, pharmacological experiments and pathophysiological experiments. That system integrates functions of a stimulator, a recorder, and an oscilloscope on an integrated circuit panel, imitate the manipulative interfaces of four channel physiology recorders, and do the sampling, monitoring, saving, analyzing and panting the signals by a compute. See Figure 2-1.

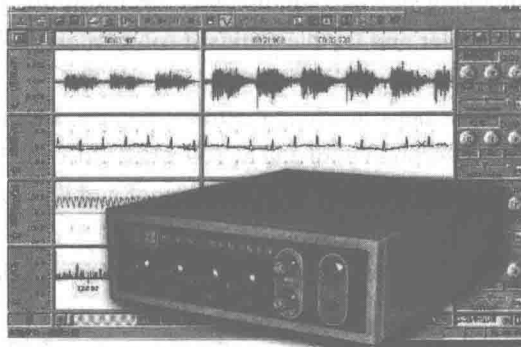


Figure2-1 “BL-420 Biological data acqusition and analysis system”

[Operation methods]

- (1) Switch on the power of computer.
- (2) Double Click the icon of “BL-420 Biological data acquisition and analysis system” on the monitor.
- (3) Click “Experimental item” to choose experiment project.
- (4) Regulate relevant parameter.
- (5) Click the start icon and record.
- (6) Press “pause” button to edit or print graphics.
- (7) Click the stop icon and finish the record.

- (8) Select “exit” in the “File” Menu of BL-420 Software to exit the software.

II . 721 Type spectrophotometer

721 Type of visible spectrophotometers are made in Shanghai. It is a kind of single-beamed instrument and its slit is fixed. That type of spectrophotometer is mainly used to measure absorption of light whose wavelength is in the range of 360-800nm, and it is suitable to analyze high difference of absorption luminosity. See Figure 2-2.

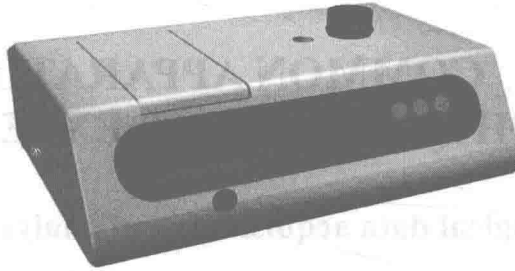


Figure 2-2 721 Type visible spectrophotometer

[Operation methods]

(1) Switch on the power, open the lid of absorption pool, adjust the knob “5” to regulate the transmittance as 0. After preheating the machine for 20 minutes, adjust the knob “4” to choose the light wavelength needed, after that, adjust the knob “8” to choose the optimal sensitivity. Regulate the knob “0” again to make light transmittance as 0.

(2) Put the cup containing standard solution into the absorption pool and close the lid, push or pull the rod of sample holder and lay the standard solution on the light beam road. Close the lid and adjust the knob “6” to regulate the transmittance as 100.

(3) Following the above steps to adjust the transmittance, set the value of transmittance at 0 when open the lid of the absorption pool and at 100 when close the lid.

(4) Put the cup containing test solution into the pool and lay it on the light beam road and close the lid, read the value of the absorption.

(5) After finishing the measurement, switch off the power and clean the cup.

[Precautions]

(1) If continuously measure for long time, the electric eye will be weary, which make the needle of reading value drifting. Please stop measuring and let the machine take a rest.

(2) When put the standard solution into the pool and adjust transmittance as 100%, please initially turn on the luminous regulator slightly. After dose the lid, enlarge die brightness little by little.

(3) The rules for selection of instrument sensitivity are: When regulate the transmittance as 100%, generally set the instrument sensitivity at X 1 grade or low-grade so that to keep the instrument stable.

III . LD4-2 Type low speed centrifuge

The low speed centrifuge is used to separate the mixed solution and make some component precipitated quickly. See Figure 2-3.

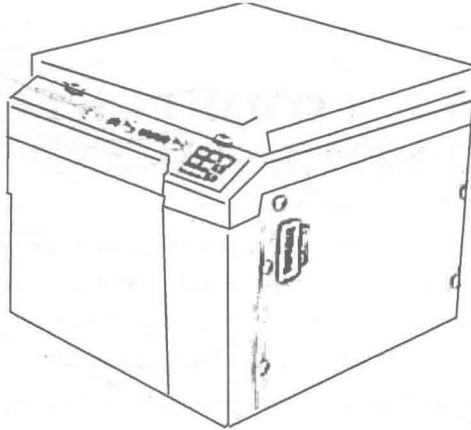


Figure 2-3 LD4-2 Type low speed centrifuge

[Operation methods]

- (1) Put the centrifuge on the steady ground or the steady table.
- (2) Keep the load balance, put all the load symmetrically.
- (3) The handle should be in the low speed position, the switch should be in the off position and the cover should be locked with the vessel tightly.
- (4) Turn on the switch.
- (5) Move the timing handle steadily till the tachoscope indicates the required rotation speed; After 1-2 minutes when the speed becomes steady, start to count time. When centrifuge is finished, turn off the switch.

Section 2 COMMON SPECIES OF EXPERIMENTAL ANIMALS

“Experiment animals” is the term to describe animals that are bred and raised with scientific methods for the purpose of biological and medical research or teaching. Animal testing, also known as animal experimentation, animal research, and in vivo testing, is the use of non-human animals in experiments (although some research about animals involves only natural behaviors or pure observation, such as a mouse running a maze or field studies of chimp troops). The research is conducted inside universities, medical schools, pharmaceutical companies, farms, defense establishments, and commercial facilities that provide animal-testing services to industry. It includes pure research (such as genetics, developmental biology, and behavioral studies) as well as applied research (such as biomedical research, xenotransplantation, drug testing, and toxicology tests, including cosmetics testing).

The goal of any experiment is to determine the effects of defined experimental variables in a controlled environment. When working with biologic systems variability between experimental animals can confound the interpretation of results. By selecting appropriate animals an investigator will reduce experimental variability. This will result in the use of fewer animals and less work to produce significant results. In general, several factors can reduce experimental variability: ① Use inbred animals from the same source when possible. ② Do not use animals with open wounds or other signs of illness or injury. ③ Do not use animals that display abnormal behavior. ④ Protect animals from infection with potential pathogenic microorganisms. ⑤ Select endpoints that will not introduce additional variables. Complete the study before animals become moribund or develop ulcerated, necrotic or infected tumors. ⑥ Use aseptic technique when preparing for and performing surgery. Shave the fur and scrub the surgery site. Select an appropriate method of sterilizing instruments for surgery.

Commonly used animals for functional experiments include toad, mouse, rat, rabbit, guinea pig and dog, etc. Most of these animals are mammals, whose physiological traits are close to those of human.

I . Toads and frogs

Both toads and frogs pertain to amphibia, anura. Their hearts can keep beating for time under in vitro condition and are suitable for medication experiments of cardiac insufficiency; their sciatic nerve-gastrocnemius samples can be used to observe drug effect on peripheral nerves, nerve-muscular junctions or striated muscles; while their tongue and intestinal mesenterium are good samples for observation of inflammation and microcirculation

II . Mice

Mice belong to mammalia, rodentia and murinae. Mice are the most commonly used animals in medical experiments. They are mainly used in drug screening, drug potency

comparison, anti-infection and anti-tumor experiments, establishment of models for semi-section and cross-section of spinal cord and hypoxia, etc. The basic biologic and physiological data are showed in Table 2-1 and Table 2-2.

Table 2-1 Basic biologic data of mice

INDEX	QUANTITATIVE VALUE
Adult body weight: Male	20-40gm
Adult body weight: Female	18-35gm
Life span	1.5-3years
Food consumption	15gm/100gm/day
Water consumption	15ml/100gm/day
Breeding onset: Male	50days
Breeding onset: Female	50-60days
Gestation period	19-21days
Body temperature	36-37°C

Table 2-2 Physiological data of mice

INDEX	QUANTITATIVE VALUE
Heart rate (beats/min)	330-780
Respiratory rate per min	84-230
Tidal volume (ml)	0.1-0.23
Hb (g/100ml)	10-19
RBC (million/mm ³)	4.9-12.5
WBC (thousands/mm ³)	4-12
Blood volume (% B.W)	7-9

III. Rats

Rats also belong to mammalia, rodentia and murinae. However, rats are not as docile as mice. When frightened, rats could become fierce and are prone to bite. Rats are suitable for the experiments which mice are not suitable, e.g. observation of anti-inflammatory effect, biliary tract intubation, model establishment of shock, edema or hypoxia, subacute or chronic drug toxicity experiments. The basic biologic and physiological data are showed in Table 2-3 and Table 2-4.

Table 2-3 Basic biologic data of rats

INDEX	QUANTITATIVE VALUE
Adult body weight: Male	300-500gm
Adult body weight: Female	200-300gm
Life span	2-3.5years
Food consumption	10gm/100gm/day
Water consumption	10-12ml/100gm/day
Breeding onset: Male	65-110days
Breeding onset: Female	65-110days
Gestation period	21-23days
Body temperature	38-39°C