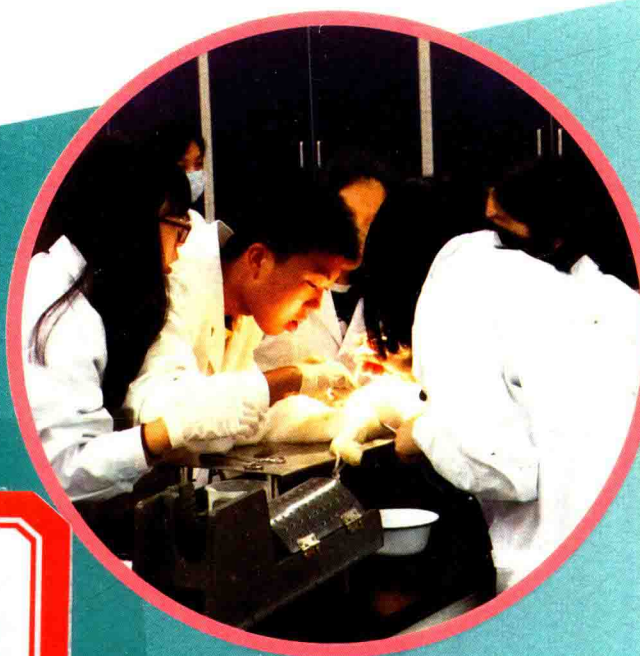


Guideline to Physiological Experiment *and* Fundamentals of Medical Research

生理学实验指南 及医学研究基础

王跃春 主编



暨南大学出版社
JINAN UNIVERSITY PRESS

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王庭槐*

暨南大学德高望重的生理学老教授王子栋先生打来电话，请我为王跃春老师编写的《生理学实验指南及医学研究基础》一书写序。我和王跃春老师素未谋面，对她了解不多。但既然本书是王子栋教授指导和推荐的，主审也是我很熟悉的在生理学学术上造诣深厚的王立伟教授，我想这本书必定是质量上乘的力作。我仔细阅读了全书，了解了编者的意图，便把读后的一点感想写出来与大家分享。

随着现代科学技术的不断发展，生理学实验教学的内容和教学方法也在不断与时俱进。从记纹鼓时代到如今电子计算机仿真模拟实验平台的广泛应用，我们经历了实验技术和手段不断更新发展的演变，实验对象也在原来的两栖类和哺乳类动物实验的基础上增加了符合生命伦理学的无创人体实验。随着实验项目和内容不断增加，实验教材层出不穷。为了培养学生的创新意识和能力，不少教材还增加了实验设计和学生科研实验的内容，但由于内容繁多，教材越编越多，越编越厚，反而给学习者增添了选择上的困难和阅读上的负担。王跃春老师主编的这本《生理学实验指南及医学研究基础》克服了上述的弊端，全书采用五章的篇幅统括了现代生理学实验教材的必要内容。第一章阐述了生理学实验的要求、学习目的和意义；第二章精选了 14 个经典的动物实验；第三章选择了 12 个人体实验；第四、第五章简要介绍了医学科学研究的基础知识与实验设计的基本原理和原则，并提供了实验报告书写和研究论文发表的资料。这样的编排反映了作者在本书构思和内容选择上的精雕细琢，颇具匠心。在保留了生理学实验的精华内容的基础上，作者还在书中每个实验后面增加了相关问题，为学生提供拓展性学习和研究性学习的空间。此外，书中还介绍了与实验相关的“诺贝尔生理学或医学奖”的核心内容，集知识性、趣味可读性和科学实用性于一体。这有助于培养学生科学思维能力和人文精神，也是本书最为突出的优点。

本书的适用对象主要是国际学院临床医学、药学和 MBBS 专业的学生，因此全书采用英文编写。这也为生理实验教学的老师、技术人员和有意学习生理学专业英语的医学生提供了参考和选择。

阅读本书的时候，我可以体会到王子栋教授、主审王立伟教授在指导本书编写中付出的心血和对青年教师的殷切期望，这也是老一辈生理学科工作者严谨细致、求真务实的治

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学态度代代相传的学术传统。我还要为王跃春主编和参加本书编写的作者们点赞，在本书的编写过程中，他们在做了大量收集、筛选、浓缩、精简的工作的基础上，将自身多年实验教学经验概括总结并大胆探索创新，体现了教与育相结合的人才培养理念，这是十分难能可贵的。

现代科技一日千里，生理科学实验的发展也必将日新月异。我对未来实验生理科学的发展也有如下的看法和期待：①实验教学应更加体现对生命的尊重，珍视生命的教育应贯穿在实验教学中。②模拟教学部分代替动物实验体现了人类文明的进步且必将逐步成为主流。③现代医学实验课教学应紧跟时代的步伐，新仪器、新设备、新技术应逐步应用于实验教学。④目前国内的生理实验教材是百家争鸣、百花齐放，但也存在良莠不齐、内容落后于学科发展的现象，这呼唤着内容创新、技术先进和密切联系临床应用实际的新教材的问世。⑤处理好经典实验与现代实验技术结合的关系。⑥虚拟实验具有不受学习时间和空间限制的优势，因此提倡线上线下，虚实结合式的混合教学，而虚拟模拟与真实体验式教学相结合是十分必要的。⑦实验教学队伍的建设是关键，科学管理是保障。⑧主动学习的同时还须研究拓展性学习。⑨在 MOOC 时代，充分利用 MOOL、MOOR 以及新的关联主义学习理论进行深度学习，在不断推进实验技术更新的同时，进一步实现网络化、开放性、综合性与有效性，为培养高素质、创新型医药人才奠定基础是创新生理学实验教学改革的新途径。⑩随着第四次工业革命的到来，智能化学习、深度学习；AR、VR 技术学习；混合学习；合作学习；BYOD 学习：Bring Your Own Device；可穿戴技术；自适应学习技术等，将深刻影响并推动生理学及生理学实验教学的发展。

展望智能时代，我们心潮澎湃，希望寄托在年轻生理学工作者的身上，愿你们在激动人心的新时代不断探索、勇于创新、大步向前、开创未来！

王麓槐

2018 年 3 月 23 日于广州

Preface

Wang Zidong, a prestigious professor in Physiology in Jinan University, called and invited me to write a preface for the book *Guideline to Physiological Experiment and Fundamentals of Medical Research*, which was written and edited by Dr. Wang Yuechun. This textbook is recommended and guided by professor Wang Zidong, and reviewed by professor Wang Liwei, another excellent professor in Physiology whom I am very familiar with, I believe this textbook is a masterpiece of quality. Having read the draft carefully, I can understand the intentions of the editor, and I would like to share some of my thoughts with you.

With the increasing development of modern technology, the contents and the teaching methodology of physiological experiments advance with time. From the era of using kymograph to the age of universally applying computer simulation experiment platform, experimental techniques and instruments have undergone great changes. The experimental subjects extend as well, from only amphibians and mammals to human beings in non-invasive human experiments that meet bioethics. Therefore, experimental textbooks crop up endlessly. To cultivate students' creative awareness and ability, many textbooks even include contents of experiment designing and research experiments for students. However, students have difficulty in selecting and reading textbooks which are various in contents and large in size. Nevertheless, this textbook, *Guideline to Physiological Experiment and Fundamentals of Medical Research*, overcomes the above drawbacks as it covers the essential content of modern physiological experiment using only five chapters. The first chapter describes the requirements of physiological experiment, learning objectives and significance; the second chapter includes 14 representative animal experiments while in the third chapter, 12 commonly performed human experiments are selected. The fourth and fifth chapter introduce the fundamentals of medical research, some basic principles of experimental design and some skills and materials for writing experimental reports and submitting scientific papers. Such an arrangement of contents reflects the author's meticulous elaboration in designing the textbook and selecting the contents. The book retains the essence of physiological experiment. In addition, professor Wang also raises some related questions at the end of each experiment for students' expansive and investigative learning. Moreover, Dr. Wang also attaches some relevant materials of the Nobel Prize in physiology or medicine to each experiment, integrating knowledge, interesting readability and scientific practicality all in one. With all these together, this textbook can help cultivate students' scientific thinking and humanistic spirit, which is the most outstanding asset of this textbook.



The textbook written in English is mainly intended for students majoring in clinical medicine, pharmacology and MBBS of international school. It also provides reference and choices for teachers and technicians who teach physiological experiment, and the students who want to study Physiology in English.

When reading this book, I can feel the efforts of professor Wang Zidong and chief reviewer professor Wang Liwei paid in guiding and editing this textbook and their expectations for young teachers. This book is the embodiment of the rigorous, meticulous and practical attitude of the older generation of physiologists and the academic tradition handed down from generation to generation. Moreover, I would like to praise Dr. Wang Yuechun and the authors involved in editing this textbook. In the process of writing this book, they have done a lot of work in collecting, screening, concentrating, simplifying and summarizing their own experimental teaching experience and boldly explored innovative solutions, which embodies the idea of combining talent cultivation with education. This is very commendable.

With the rapid development of modern technology, the development of experimental physiology is bound to change with each passing day. Besides, I also have the following views and expectations for the development of experimental physiology:

① The teaching of experiments should show more respect for life, and the awareness of cherishing life should always be carried throughout the experimental teaching. ② Simulation teaching substituting some of the animal experiments not only embodies the advances of human civilization but also will become the main stream gradually. ③ The modern medical experimental teaching should follow the pace of the times, applying new instruments, device and technology to the teaching of experiments. ④ Although the textbooks of experimental physiology keep emerging, there are also books whose contents are not good in quality and lag behind the development of the science, which calls for the new textbooks with innovative contents, advanced technology and close connection with the clinical application. ⑤ Find out a better way to deal with the relationship between classic experiments and the application of modern experimental techniques. ⑥ Virtual experiments are not limited to time and space, so it is necessary to promote the combination of online and offline teaching, simulating and experiencing experimental teaching. ⑦ The construction of experimental teaching team is the key, which is guaranteed by the scientific management. ⑧ Active learning and extensive learning are both needed. ⑨ In the era of MOOC, fully utilize MOOL, MOOR and other new theories for further learning. In the meantime of continually updating experimental techniques, the further realization of networking, openness, comprehensiveness and effectiveness must be achieved so as to lay foundations for the cultivation of high-quality and innovative medical talents, which is the new approach to reform innovative experimental physiology. ⑩ With the coming of the fourth industrial revolution, intelligent learning, deep learning; AR, VR technology; mixed learning; cooperative learning; BYOD learning (bring your own device); wearable technology; adaptive learning techniques, etc. will profoundly influence and promote the development of physiology and experimental physiology



teaching.

In the age of intelligence, we are far beyond excited. We hope the younger generation of workers in physiology keep exploring and innovating to usher in a new era.

Translated by Wang Yuechun

23rd Mar. , 2018 in Guangzhou

Table of Contents

| | |
|---|----|
| 序 | 1 |
| Preface | 1 |
| Chapter I Introduction to Physiological Experiments | 1 |
| Section 1 General course description of physiological experiments | 2 |
| Section 2 Laboratory rules and requirements of physiological experiments | 3 |
| Section 3 The development of physiological experiment and basic types of physiological experiment | 6 |
| Section 4 Preparation for common reagents used in physiological laboratory | 10 |
| Section 5 Formats and requirements of physiological experimental reports | 13 |
| Chapter II Animal Experiments | 17 |
| Section 1 Basic technique for amphibian animal experiments | 18 |
| Section 2 Basic technique for mammal experiments | 22 |
| Section 3 Basic technique for rodent animal experiments | 28 |
| Section 4 BL-420 biological data acquisition and analysis system | 30 |
| Section 5 Specific animal experiments | 44 |
| Experiment 1 Sciatic-gastrocnemius preparation | 44 |
| Experiment 2 Threshold, supra-threshold and maximal stimulus | 47 |
| Experiment 3 Single muscle twitch, frequency summation, and tetanization | 50 |
| Experiment 4 Action potential of nerve trunk | 53 |
| Experiment 5 Conduction velocity of compound AP of nerve trunk | 58 |
| Experiment 6 The pacemaker of frog heart | 60 |
| Experiment 7 Extrasystole and compensatory pause of the frog heart | 63 |
| Experiment 8 Osmotic fragility of the red blood corpuscles | 66 |
| Experiment 9 Regulation of respiration movement | 70 |
| Experiment 10 Regulation of cardiovascular system | 75 |
| Experiment 11 Physiological properties of smooth muscle of digestive tract | 79 |
| Experiment 12 Factors affecting urinary formation | 83 |
| Experiment 13 The reflex arc | 87 |
| Experiment 14 Ataxia induced by cerebellar injury in mouse | 90 |



| | |
|---|-----|
| Chapter III Human Experiments | 93 |
| Section 1 Introduction to WebChart – 400 system for human experiments | 94 |
| Section 2 Specific human experiments | 102 |
| Experiment 1 Recording of human respiratory movement | 102 |
| Experiment 2 Detection of heart sounds | 106 |
| Experiment 3 Measurement of blood pressure | 109 |
| Experiment 4 Recording of an electrocardiogram | 115 |
| Experiment 5 Determination of ABO blood types | 122 |
| Experiment 6 Examination of visual acuity | 126 |
| Experiment 7 Examination of visual fields | 129 |
| Experiment 8 Examination of blind spot | 132 |
| Experiment 9 Examination of color blindness | 135 |
| Experiment 10 Conduction ways of sound | 138 |
| Experiment 11 Induction of knee jerk reflex | 142 |
| Experiment 12 Human auditory and visual responses | 145 |
| Chapter IV Fundamentals of Medical Research | 148 |
| Section 1 Scientific method and experimental medicine | 149 |
| Section 2 Basic principles of experimental medicine | 155 |
| Section 3 Guidelines to write and publish a research paper | 161 |
| Chapter V Experimental Design | 170 |
| Section 1 Introduction to experimental design | 171 |
| Section 2 Methods for designing a good physiological experiment | 174 |
| Section 3 An example of physiological experimental design | 176 |
| Section 4 An example of a full lab report | 179 |
| Section 5 Suggested topics for physiological experimental design | 187 |
| Appendix | 192 |
| Appendix 1 Laboratory syllabus for physiological experiment(Applicable to clinical medicine) | 192 |
| Appendix 2 Laboratory syllabus for human physiological experiment(Applicable to phamacology) | 197 |
| Appendix 3 Grade table for examination in physiological experiments | 200 |
| Appendix 4 An example of physiological experimental report | 201 |
| Acknowledgement | 204 |
| 鸣 谢 | 205 |

Chapter I

Introduction to Physiological Experiments

- Section 1** General course description of physiological experiments
- Section 2** Laboratory rules and requirements of physiological experiments
- Section 3** The development of physiological experiments and basic types of physiological experiment
- Section 4** Preparation for common reagents used in physiological laboratory
- Section 5** Formats and requirements of physiological experimental reports



Section 1

General course description of physiological experiments

Physiology, one of the branches of biological science, deals with the phenomena exhibited by living organisms. It is a study on the normal functions of organs and systems, the conditions under which these functions are carried out, and the mechanisms by which they are achieved. The theories of physiology are based on a large number of animal and human experiments, so physiology is actually an experimental life science.

Physiological experiments were designed for medical students or those of related majors (including clinical medicine, pharmacology, nursery, Chinese medicine, MBBS et al.) to further understand the physiological theories, obtain the basic in vivo and in vitro experimental techniques; develop the abilities to address, analyze and solve scientific questions and get to know the processes and skills to publish research papers from the experience in designing experiments and writing laboratory reports. Briefly, the main aims of this course are to develop familiarity with and competence in elementary physiological techniques for medical students, and to improve their practical abilities to conduct scientific research in the future.

This course consists of 25 physiological experiments (including animal experiments and human experiments), the experimental design and lab discussions which were selected considering the following aspects: not only can they help students better understand the physiological principles, but also can give students a basic training in scientific research.

At the end of this course, students should be able to:

- ◇ Master the essential surgical techniques ordinarily carried on in physiological laboratory.
- ◇ Perform physiological experiments correctly as required.
- ◇ Understand the significance and measurement of basic physiological indices.
- ◇ Know how to write a required experimental report which is the initial practice for later scientific paper writing.
- ◇ Understand the general principles and methods of designing physiological experiments.



Section 2

Laboratory rules and requirements of physiological experiments

In view of the importance of physiological experiments, everyone should value the opportunity to perform experiments and make sure the high quality of the results. It is absolutely forbidden to abuse the animals or the experimental apparatus. Keep in mind that the laboratory is a place where you can observe, manipulate, and experience hands-on activities that will dramatically enhance your understanding of the lecture presentations.

1. What should students do before each experiment

Students should prepare sufficiently before each experiment. It is necessary to read the experimental guide carefully, understand the basic principles and methods, review the relevant parts in anatomy and physiology, and anticipate the results and possible problems. The experimental course is used for high-quality learning. It is welcome to address questions after critical thinking instead of following instructions blindly.

- ◇Preview the teaching schedule and know which experiment will be done.
- ◇Read the experimental guide and know what, why and how to do the experiment.
- ◇Do pre-lab reading which covers related theoretical information and try to predict the results and raise questions.

2. What should students do during experiments

It is not allowed to wear open-toe shoes to enter a lab. Please wear white gown and remember to set your phone on silent mode when class begins and not to eat, drink or make noise in the classroom. During experiments, everyone must observe the laboratory rules, make minimal noise, and concentrate on the experiment. Only one student in each group is responsible for borrowing and returning experimental apparatus when necessary. Divide the labor within the group, try to work seriously and efficiently as a group.

◇Come to the lab on time (normally class begins at 2:30 pm), and ten minutes later the door will be closed. Everyone who doesn't ask for leave before class or can't show leave permission in class will get zero for the experiment. Most instructors explain what the lab is about, pitfalls to avoid, and the sequence or format to be followed at the beginning of the lab session. If you are late, you will not only miss the information, but also interrupt the course, which is quite impolite.

◇Listen carefully to the instructor at the beginning of the class, especially focus on the Do's and Don'ts which determine whether you can complete the experiment successfully or not.

◇Keep your work area clean and neat. Move books and coats out of the bench, in case errors



and accidents may occur.

- ◇ Observe carefully when the instructor makes demonstrations.
- ◇ Use apparatus and softwares correctly. Do not use any laboratory equipment until you have received written or oral instructions regarding their usage. If the equipment is out of order, you should tell the instructor to have a check on them.
- ◇ Conduct the experiment step by step according to the procedures.
- ◇ Observe the experimental phenomena patiently and take notes in time and accurately. Keep complete records of all data. Correlate the collected data with the pertinent material in your textbook.

3. What should students do after experiments

After experiment, each group should clean the experimental benches, save the experimental materials, and return the experimental apparatus. Deposit all dead animals in designated places. The on-duty group cleans the lab. Last but not least, collect and sort out the raw recordings, write the report, and hand it in on time.

- ◇ Separate the specimen from the facial tissue and plastic gloves. Specimen should be put into the yellow plastic bag or assigned places and other garbage be put into the trash can.
- ◇ Each group member should clean all the instruments, gauze and the benches they used.
- ◇ One group should be arranged by the monitor to clean the whole lab including mopping the floor and taking out the trash.
- ◇ Write the experimental report according to the required format and requirements on your own and submit it on time.

4. Basic laboratory safety guideline

Eating, drinking and smoking are not allowed in lab. Tie back long hair, and restrain loose clothing and jewelry.

Locate exits, fire aid kit, sharps container and wash station in your laboratory.

In human experiments, no one is required to be a subject. Do not volunteer if you have a heart or respiratory disorder. If the subject feels any discomfort in the experiment, stop the experiment immediately and inform the instructor. Inform your instructor if you are in a special medical condition on special medication or are pregnant.

In animal experiments, you will be expected to treat them humanely. Any inconsiderate treatment on laboratory animals will not be tolerated.

Assume that all lab chemicals are sources of potential danger to you. Follow directions to use them. Do not use your mouth to ingest chemicals or pipette any substance.

Wash your hands thoroughly after each lab. Additionally, clean your work area after each lab.

Inform the instructor immediately if you spill any chemicals on yourself. Inform the instructor if you are bitten or scratched by any animal in the lab.



Safety glasses must be used for experiments involving chemical solutions.

Disposable gloves must be worn when handling body fluids (e. g. blood, urinalysis) .

Consult the instructor about instructions when disposing of sharp, or contaminated supplies, or for the disposal of chemicals.

Consult the instructor about the disposal of the body of animals when completing the experiment. Experimental animals need to be executed before the disposal.



Section 3

The development of physiological experiment and basic types of physiological experiment

Physiology is the basic medicine subject to study the law of life activities in normal human bodies. As a result of the introduction to animal experimental research methods, physiology has become a modern science and therefore, it is not only a theoretical subject, but also an experimental subject. The theories about the functional activities are based on the experiments. Setting up physiological experiments not only enhances the students' ability to master the basic theory of medical knowledge and techniques, but also cultivates students' innovation consciousness and independent thinking with scientific methods. When we study the basic theory of medicine, we are bound to consider its experimental bases, experimental methods and the reliability of the results.

1. The development of physiological experiment

How do human beings understand the objective world and how do they acquire knowledge? The history of science is a powerful demonstration of the importance of human practice.

From the fourth century BC to the third century BC, Aristotle, the founder of Greek biology, applied anatomical techniques to demonstrate the internal differences of various animals, which is the first western literature on animal experiments. In ancient Rome, Dr. Galen made a study of the physiological function of the human body by preliminary living anatomy of a variety of animals, which had a great impact on the development of medicine. He thought experiment plays a significant role in the progress of science. In the seventeenth century, William Harvey, a British physician, used an autopsy method to conduct many experiments on several animals. In this way, he clarified the pathways of blood circulation and pointed out that the heart is the center of the circulatory system. In 1628, he published his work *On the Motion of the Heart and Blood*. It is the first book on physiology based on experiments and marked the appearance of modern physiology. The discovery of the blood circulation has made physiology develop into a subject, and establish the scientific research method of physiology, which has created a new era for experimental pharmacology. In the nineteenth century, people began to realize that only clinical observations and autopsies could help them get comprehensive and profound understanding of the diseases. They began to produce human diseases in animal models to investigate the causes and conditions of diseases, and the dynamic changes of function and metabolism during the diseases course. They further revealed the internal relationship between various clinical manifestations and changes in the body, clarified the mechanism and development of diseases, and rationally understood the essence of diseases. In 1865, Claude Bernard, a French physiologist, is the first advocator to use living