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

TEXTBOOK OF MEDICAL FUNCTIONAL EXPERIMENT

医学机能实验学

英文版

Yiping Sun（孙艺平）　Yuan Zou（邹　原）　主编
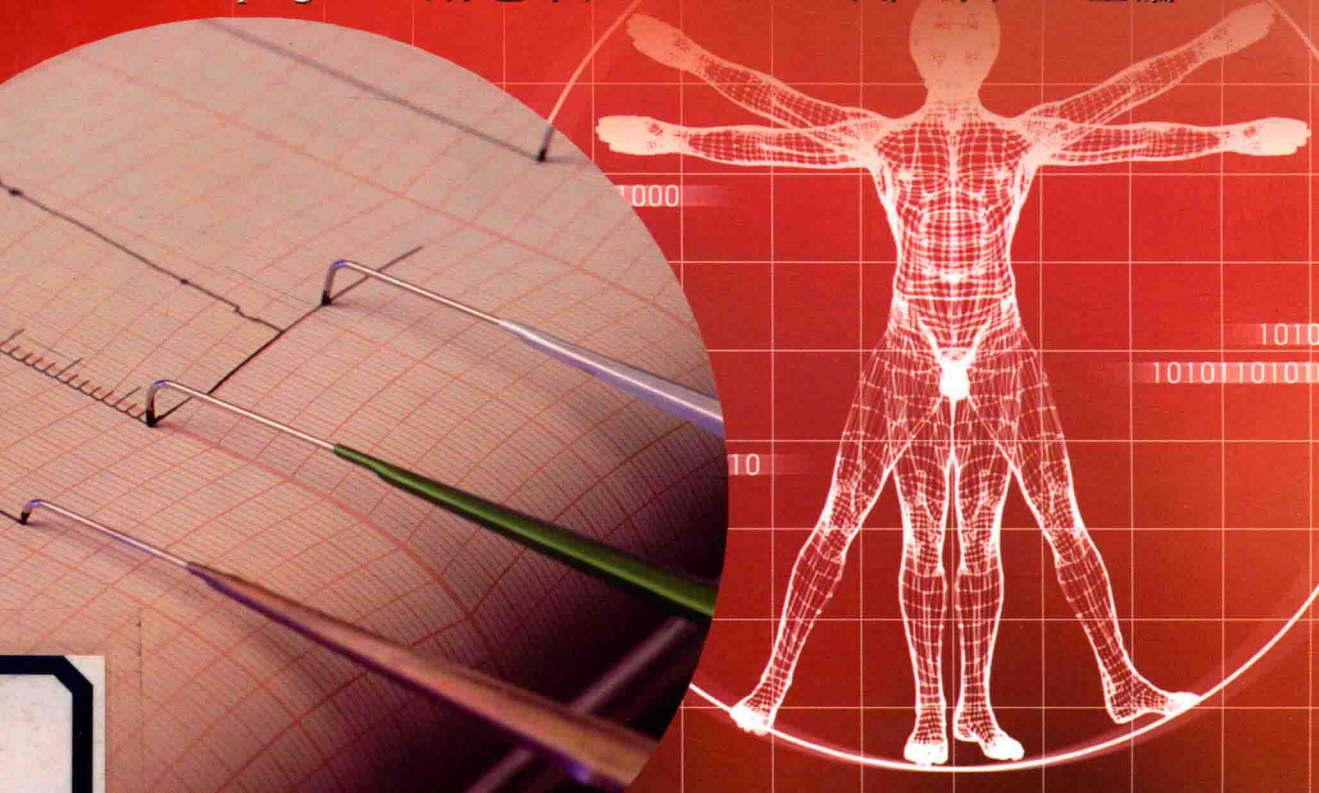
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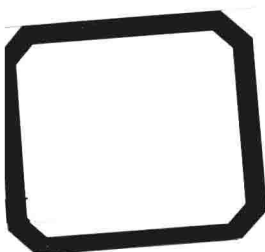
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Content Synopsis

This English textbook is for the medical functional experiments. There are five chapters, mainly including classical experiments in the field of physiology, pathophysiology or pharmacology. There are also chapters on the basic techniques about animal operation or use of experimental instruments. The detailed content together with the vivid artwork make it easily understood.

This textbook is aimed at students of the professions allied to medicine. Moreover, it can be reference for the medicine teaching.

内 容 简 介

本书为机能学实验的英文教材，全书共分为五章，主要包括生理学、病理生理学、药理学实验中常见的、经典的实验内容，另外还涉及了相关的实验仪器、动物实验的基本操作技术等，内容较为详尽，图文并茂，通俗易懂。

本教材可作为国内医学院校留学生机能学实验教学的教材，也可作为国内医药院校、综合性大学等相关专业学生学习机能学实验的英文教材及教师和相关人员的教学参考书。

Preface for Adaptation Edition

Bilingual teaching, for example ,in both Chinese and English, has been long promoted in China. However, we still lack a satisfactory textbook of medical functional experiment. Original editions of textbooks in English from abroad are not only too expensive for students but also somewhat unsuitable for teaching. Therefore there is a great demand for a suitable textbook. For this purpose, Science Press organized us to compile this textbook.

Actually for Chinese authors to rewrite the original textbook of medical functional experiment in English is not easy because we have not yet had such experience before. We are deeply indebted to all the authors who have done their great endeavors to adapt and review the chapters in their areas of expertise. A lot of extra time with short notice was used to complete this edition accurately as well as quickly. We are particularly thankful to those famous professors, for helping in reviewing and correcting the English for some chapters.

There could be some errors in spelling or grammar in English, even in the basic knowledge of medical functional experiment. There is still room for improvement in future if it is republished. Hopefully the medical faculties and students will use this book and provide helpful suggestions and critiques in the future.

Yiping Sun , Yuan Zou
September, 2009

前　言

　　为使医学教育逐渐同世界接轨，双语教学在我们国家已经倡导和推行多年，但至今仍然缺乏令人满意的医学机能实验学教科书。英文原版教材价格较高，且与中国目前的教学内容不甚吻合。基于对英语双语医学机能实验学教材的广泛需求，科学出版社组织我校教师出版了本书。

　　由于缺乏经验和英语水平所限，虽是改编，实属不易。各位编委在担任繁重的医学教研工作的同时，夜以继日、辛勤劳作，在较短时间内完成了初稿和互审。本书编委们在沟通信息和编写过程中做了大量卓有成效的工作。在最后定稿期间，我们又邀请了知名专家对全书的英语修辞和语法提出了建议和修改，在此表示衷心地感谢。

　　本书在章节内容衔接上，尤其是英语语言表达上，疏漏和错误之处在所难免。恳请同道和学生在实际使用过程中，不断提出意见，以期再版时进一步完善。

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孙艺平　邹　原

2009 年 9 月

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Contents

Introduction: Medical Functional Experiments

1. The outline of medical functional experiments

Functional experiments on medicine mainly include the experimental content of physiology, pathophysiology and pharmacology. They are professional basic experimental classes of medicine. Physiological experiments study the regularity of vital movement of organism and the effect and mechanism of medicine with normal animals. Pathophysiological experiments explore the general regularity of some typical diseases using the replicated animal models of some diseases. Pharmacological experiments research the effect and organism of drugs through their effects on functional activity to tissues or organs of animals.

2. The aim of medical functional experiments

Students can not only grasp basic operating techniques from the experiments, but also understand scientific methods of how to acquire a knowledge of physiology, pathophysiology, and pharmacology and other related ways so as to build substantial foundation for further clinical theoretical study and practice. Functional experiments can cultivate abilities of students to operate and analyze and solve problems with theoretical knowledge nimbly, meanwhile they can create compact attitude towards science and set up working styles that seek truth from fact.

3. The request of medical functional experiments

(1) Before 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. Noticing and estimating errors in the experiment is important so as to find and correct errors on operation in time.

(2) During the experiment: First, know the correct method of how to use equipments, examine their function and debug them. Second, operate as the step says and accurately estimate the quantity of medicine 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, analyze results of the experiment by combining the theories that have been learned.

(3) After the experiment: Students should put the record they made in order and fill 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.

4. The treatment on medical functional experiments

During the experiment, students analyze, estimate and sort results that have been observed, detected and calculated. They change the results into qualitative and quantitative data and charts in order to analyze various kinds of the changing regularity inside.

Among the results, if indexes can be detected quantitatively such as length, height, speed, weight and so on, students should quantitate them with correct units and figures. If charts or pictures are used to indicate the results, students should indicate the titles of charts or pictures. When making charts, students should list the observed programs on the left while fill in the changing figures of each program's result in order on the right, and brief explanation is also permitted. When drawing axis of abscissas is used to indicate different kinds of stimulant conditions while axis of ordinates indicates different responses that have happened. Axis of coordinates should have appropriate explanation including dose unit. Students can choose suitable scale to plot, and definite the length of coordinate according to the size of the picture. Curve or turning curve which crosses every point must be smooth and glossy. If it isn't continuous change, column diagram with conditions and subject of the experiment below is also appropriate. Results should be evaluated on the condition that data of the experiment are handled according to health statistics.

5. Writting request of medical functional experiments

Everyone should write a report on the experiment that has been done by himself. And the report must be submitted to the teacher on time.

Write carefully as requirements say. Notice the concision of words, fluency, distinctness and tidiness, and use punctuation mark correctly.

The content of report is 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:

Functional   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:

6. The rule of the laboratory

Students should obey disciplines of school, reach the lab on time and wear working clothes.

(1) Be serious during the experiment and don't make any action which has nothing to do with the experiment. Keep quiet in the lab from the beginning to the end.

(2) Experimenters must have an intimate knowledge of the function and operating request of the equipment first, and then use it by themselves. If there is something wrong with the equipment, students should inform the teacher immediately in order to maintain or have a change in time. Keep in mind that don't do it oneself. Animals for the experiment are divided into groups, and if additional supply is needed, students should ask the teacher for agreement.

(3) Each group should take care of their own equipment, and not exchange with other groups; If additional supply is needed, students should ask the teacher for agreement. Everyone should make an inventory of the equipment and supply for the experiment.

(4) Everybody must treasurer public property, take good care of animals for experiment, and save the equipment and supplement for the experiment.

(5) Students should keep the lab clean and tidy, and not take unnecessary articles into the lab except experimental guidance, teaching material of the subject and primary recording paper. After the experiment, students should put away equipment, supplement and tables and chairs for the experiment. Animals' bodies and waste should be put in places that have been appointed instead of dropping them at any other places.

(6) All students are divided into eight groups. Each group is in charge of taking animals from the place where feed animals an hour before class. Each group should take the cleaning work of the lab by turns, and take care of water, electricity, doors and windows and so on. Students can leave the lab after the teacher has examined.

(Shengming Yin, Yiping Sun)

Section 1: Common Apparatus Used in Functional 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 oscilloscoper on an integrated circuit panel, imitate the manipulative interfaces of four channel physiology recorders, and do the sampling, monitoring, saving, analyzing and printing the signals by a computer.

【Principles of BL-420 System】

From the broad sense, Biological data acquisition and analysis system refers to such a kind of system: Teachers and students can observe bioelectrical signal waveform or non-bioelectrical signal waveform such as tension, pressure, temperature and so on detected in various kinds of living organisms or in vitro organs through this system so that the functional change in living organisms under different physiological or pharmacological experimental conditions can be recorded and analyzed. Biological data acquisition and analysis system is one of the main equipment and means for research into the biological functional activities.

The basic principle of BL-420 (or BL-410) Biological data acquisition and analysis system is as follows. See Figure 1-1: At first the original biological signals, including bioelectrical signal, and non-bioelectrical signals introduced by sensor are amplified (some bioelectrical signals are very weak. For example, the signal from the depressor nerve discharge is a kind of microvolt-level signal. Such signal can not be observed at all without pre-amplification) and filtered (As many interfering signals including acoustic, light, electrical signals, etc. are mixed in the biological signals, such as 50Hz signal from the electric network. The amplitude of these interfering signals is always greater than bioelectrical signals themselves. If these interfering signals are not filtered, it may lead to that the useful biological signals themselves can not be observed because interfering signals are too strong); Then the processed signals will be digitalized through analog-digital conversion; The digitalized biological signals will be sent to the computer, and the computer will receive the digital signals that come from biological signal acquisition and amplification card through the special Biological data acquisition and analysis system software; After that, it will process the signals received in real time, i.e. biological function waveform display and biological function signal saving. In addition, it is capable of

specified data processing and analysis according to user command, such as smooth filtering, differential and integral calculus and spectrum analysis, etc. For experimental data that are stored in the computer, Biological data acquisition and analysis system software can recall them for observation and analysis at any time, and can print important experimental waveform and analytical data.
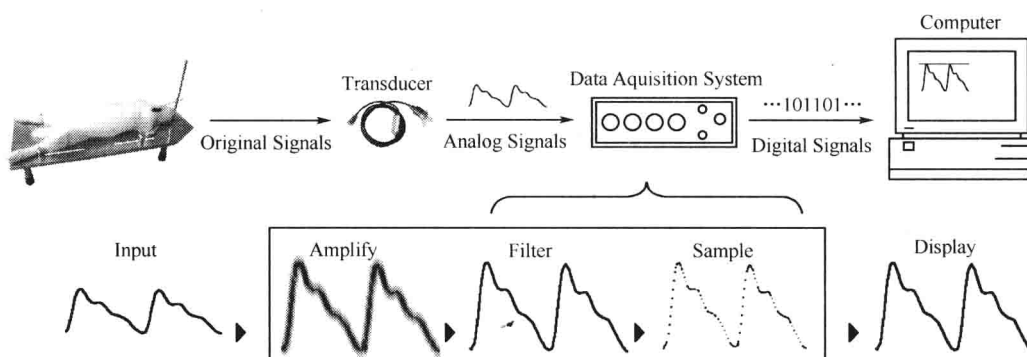

Figure 1-1   Elementary diagram of BL-420 biological data acquisition and analysis system

【Characteristics of BL-420 System】

1. Performance indices of the hardware

(1) Strong anti-jamming capability; stable and reliable operation. All functions of the hardware are completed under control of software.

(2) Gain: AC, DC: 2~50000 times, adaptive to various strong and weak bioelectrical signals.

(3) Time constant: DC, 5s, 0.1s, 0.01s and 0.001s, 5 levels in total.

(4) Filter: 0.3Hz, 3Hz, 30Hz, 100Hz, 300Hz, 1KHz, 3.3KHz and 10KHz, 8 levels in total.

(5) Adopt 12-bit A/D converter. The highest sampling rate of the system reaches 100kHz.

(6) The signal-to-noise ratio is greater than 60 dB.

(7) The peak-to-peak value of the equivalent input noise voltage is less than $2\mu V$.

(8) Double-end input. The impedance to ground at either end is $10M\Omega$.

(9) The stimulator for photoelectric isolation that can be conveniently used has two modes: Voltage output (0~100V, the minimum step length is 5mV) and current output (0~10mA, the minimum step length is $1.0\mu A$).

(10) Monitoring and drop recording functions.

2. Performance indices of the software

(1) The teaching projects of physiological, pharmacological and pathophysiological experiments have been preset, including 55 experiment modules in total of 10 categories.

(2) Powerful data processing function: It is capable of integral, differential, frequency

histogram, spectrum analysis, sequence, non-sequential density histogram and other operations in real time for original biological signals or inversion data stored on the disk.

(3) Powerful data measurement function: It is capable of real-time measurement, cursor measurement, selective area measurement and Section measurement, etc. for original biological signals or inversion data stored on the disk. Various indices of the biological signals of the selected sections can be measured, such as maximum value, minimum value, mean value, peak-to-peak value, frequency, area, change ratio and duration, etc.

(4) Dual-view (the system is equipped with both left and right display systems) design thought makes BL-420 (or BL-410) System have two sets of independent display systems, which enables comparative display of waveforms in different time intervals under the condition of real-time sampling.

(5) Scanning speed of 4 channels is independent and adjustable, which is convenient for realizing the simultaneous or non-simultaneous display of waveforms of different channels.

(6) Continuous printing of the data of the whole log file.

(7) Capable of raw Data Export, Data Cutting and Graphic Cutting for inversion data. Various raw data and measured data can directly enter the Excel or Word or other Windows applications.

【Start and Exit the Software】

1. Start the software

(1) Enter Chinese WinXP operating system.

(2) A start icon will appear on the Desktop of WinXP operating system. See Figure 1-2. Double click the start icon of BL-420E + Software, this software will be started.

BL_420E+
data
acquisition
and analysis
system

Figure 1-2   Start icon of "BL-420E + biological data acquisition and analysis system" on the WinXP Desktop

2. Exit software

Select "Exit " in the "File" Menu of BL-420E + Software to exit the software.

【Main Interface】

The main interface of BL-420E + biological signal display and processing software is shown in Figure 1-3.
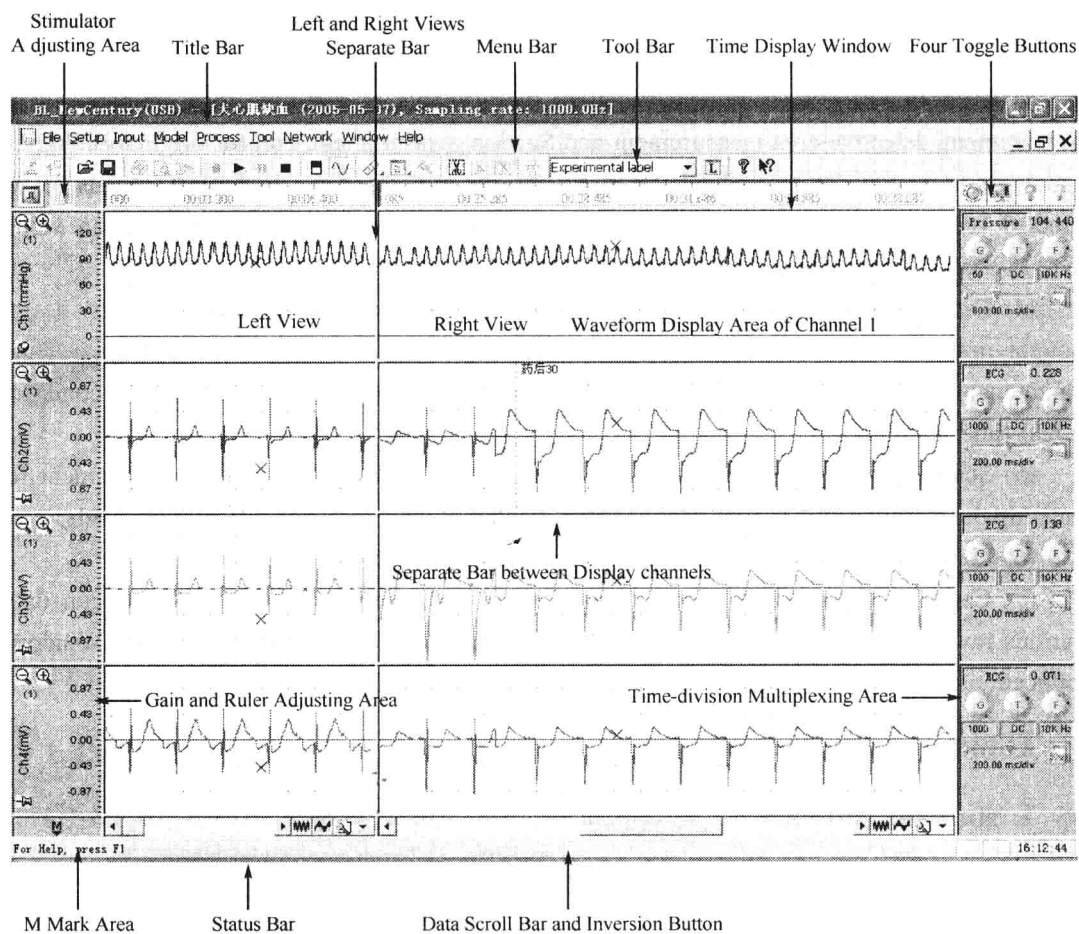
Figure 1-3　Main interface of BL-420E + biological signal display and processing software

See Table 1-1 for the function list of each part of BL-420E + Software Main Interface.

Table 1-1　Function list of each part of BL-420E + software main interface

Description	Function	Remarks
Stimulator Adjusting Area	Adjust the stimulator parameters and start/stop stimulus	Including two buttons
Title Bar	Display relevant information such as software name, experiment title, etc.	
Menu Bar	Display all top-level menus of the software. You may select a menu to pop up its submenu. A bottom-level menu represents a command	There are total 9 top-level menus in the Menu Bar

Description	Function	Remarks
Tool Bar	Aggregation of graphs of some most frequently used commands, which facilitates and visualizes the use of frequently-used commands	Including pull-down buttons
Left and Right Views Separate Bar	To separate and adjust the sizes of Left and Right Views	The total area of Left View and Right Views is fixed
Time Display Window	Display time of the log data	Display during data recording and inversion
Four toggle buttons	To switch among four Time-division Multiplexing areas	
Ruler Adjusting Area	Select ruler unit, adjust the position of ruler baseline, etc.	
Waveform Display Window	Display the original waveform of biological signals or processed waveform. Each display window corresponds to a sampling channel of the experiment	
Separate Bar between Display Channels	To separate different waveform display channels, which can also serve as an adjuster that adjusts the height of the waveform display channel	The total area of 4 display channels is fixed
Time-division Multiplexing Area	Including four time-division multiplexing subareas: Hardware Parameter Adjusting Area, Display Parameter Adjusting Area, General Information Area and Special Information Area	These subareas share the same area at the right side of the screen
M Mark Area	To save and select M mark	M mark is used during the cursor measurement
Status Bar	Display the executing status or some prompts of the current system command	
Data Scroll Bar and Inversion Button Area	For quick data search and location during real-time experiment and inversion, and at the same time adjusting the scanning speed of four channels	Display simple Stimulator Adjusting Parameter (Right View) during real-time experiment

【Experimental Item Menu】

When you click "Experimental Item" Menu on Top-level Menu Bar, "Experimental Item" Pull-down Menu will pop up. See Figure 1-4.
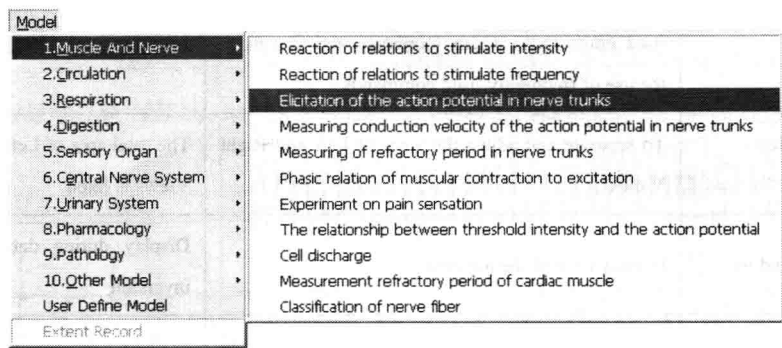

Figure 1-4　"Experimental Item" pull-down menu

"Experimental Item" Pull-down Menu contains 12 menu items, including 10 menu items that contain submenus and 2 command items, among which, 10 menu items are: Muscle and Nerve Experiment, Circulating Experiment, Respiratory Experiment, Digestive Experiment, Sensory Experiment, Central Nerve Experiment, Urinary Experiment, Pharmacological Experiment Module, Pathophysiologic Experiment Module and other experiments; 2 command items are: Customize experiment module and continuous recording function.

【Menu Items That Contain Submenus】

These physiological and pharmacological experiments are classified according to their properties. Each classified experimental item contains several detailed experiment modules. When you select certain type of experiment, such as Muscle and Nerve Experiment, a submenu that contains detailed experiment module of this type will pop up in the right. See Figure 1-4.

You may select an experiment module from the submenu according to your own needs. After you have selected an experiment module, the system will automatically set each item of parameters required for this experiment type, including Signal Sampling Channel, Sampling Rate, Gain, Time Constant, Filter and Stimulator Parameter, etc. In addition, data sampling will be automatically started, which enables the experimenter to enter the experimental state directly. When the experiment is completed, the experimental reports according to different Experiment Modules are printed, which contain different experimental data.

Generally the parameters preset in experiment module guarantee that user can complete the experiment normally. However, the biological signals are diverse, such as electrocardiosignal. Human heart rate is about 60cpm, while mouse's can reach 600cpm, therefore during the course of experiment, you may also adjust the hardware parameters according to detailed signal characteristics in order to achieve the optimum efficiency.