李淑波　王朝辉　周　艳／主编

组织学与胚胎学

（双语版）

HISTOLOGY AND EMBRYOLOGY

吉林大学出版社

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PREFACE

In order to push about the reform and development of the medical education, and to bring new education ideas, the contents and manners of teaching are becoming more and more international. The bilingual teaching has been widely popularized in the medical universities and colleges allover our country. Therefore, suitable teaching material in English is necessary to improve on international and bilingual teaching. Although the language of the original teaching material in English is standard, the width, depth and arrangement of the contents in these textbooks are different from that of the planning teaching material in our country, which makes it difficult for teachers to teach and for students to learn. And also the contents, language, arrangement and print of certain bilingual teaching material edited by internal teachers are not consummate. To meet the needs of the foreign students and bilingual teaching, all editors joint efforts to finish this Histology and embryology bilingual version.

Its characteristics are as follows:

Scientific and practical: Absorbing the essence of existing teaching material in English, taking the purposed textbook of our country as a frame, we compile this bilingual version. The breadth and depth of its contents is suitable for the students studying abroad and bilingual teaching. According to the teaching outline, the version is good with concise words, highlights and difficulties, and also some questions in each chapter. So this adapted textbook should be used conveniently for both teachers and students.

Reasonab arrangement: The typesetting sequence of the textbook edition conforms to the lectures and cognitive sequence. Meet morphological know rule: from perceptual knowledge to rational knowledge; from macro to microscopic, then molecular level. Take the structure as the main line, strengthening to the relationship between the structure and function.

Lay equal stress on drawing and wrighting: According to the morphological features, this textbook owns the high quality, excellent and typical illustrations (diagrams, micrograph and electron micrograph, etc.), in close connection with the rel-

evant content. The vivid images facilitate a better understanding of the students to its contents.

Wide application: This textbook is based on the purposed teaching material of our country, and original textbooks in English. It can be used flexibly in teaching and is suitable for the teachers and students of medical colleges, professional students in bilingual teaching and foreign students. Also it is available as reference materials for medical students of all medical majors in non – native English teaching.

The editors include middle – aged professors, scholars in teaching, scientific research and clinic, which have a wealth of the teaching experience and high sense of responsibility. Most teachers have bilingual teaching experience and go in for the teaching for foreign students. Inheriting and carrying the forward fine tradition, and referring to the education teaching in medical experiences and achievements, we make this textbook. It should be gradually more perfect, novel and applicable.

Because of our writing level is limited, it is inevitable to neglect and make mistake. It would be sincerely appreciated that the experts, especially the teachers and students those who use this book could give us precious advice.

Li Shubo

June 2011

前　言

为推动我国医学教育事业的改革、发展与创新，高等教育的教学内容和教学方式正在与国际接轨。国内各高等医学院校的留学生教学及医学部分专业双语教学也已广泛展开。适合的英文版教材是提高留学生及双语教学的必备条件。英文原版教材虽然语言文字较规范，但其内容的广度和深度，以及编排层次等与我国的规划教材有很大出入，不适于教师授课及学生阅读。现有的某些院校自编的英文版教材在内容、语言、编排、印刷等方面还存在着一些问题。为满足我校留学生及双语教学的需要，我编写组全体教师共同努力编写了本部组织学与胚胎学双语版教材。

其特色如下：

科学实用：汲取现有英文原版教材的精华，以我国规划教材为框架，形成本套《组织学与胚胎学》双语版教材。内容的广度和深度适合留学生及双语教学的要求，文字精练，重点突出，并根据教学大纲重、难点在各章内容后设部分问答题，方便教师备课、授课及学生学习、参考及复习。

编排合理：本教材编辑排版顺序符合授课和认知顺序。符合形态学认识规律：先感性认识后理性认识；先宏观后微观，再深入分子水平；以结构为主线，强化结构与功能的关系。

图文并茂：根据形态学特点，本教材精选了大量质量优秀、有代表性的插图（模式图、光镜、电镜图像等），密切结合相关内容，保证图随文走，生动形象，便于学生对内容的深入理解。

应用广泛：本套教材以我国规划教材为基础，以英文原版教材为参考进行编排。适合高等医学院校教师授课及留学生、双语授课专业学生学习使用，可以在教学中灵活运用，把握教学内容的深度和广度；也可作为医学各专业非英语授课学生的参考教材。

本编写组教师包括教学、科研及临床一线的中青年教授、学者，有多年组织学与胚胎学教学经验和高度的责任感；多数教师有留学生及双语教学经验，能够继承和发扬老一辈的优良传统，并借鉴国内外医学教育教学的经验

和成果，使本教材更趋于完善、新颖和适用。

由于我们的编写水平有限，难免有疏漏错误之处。诚挚欢迎使用本书的同行专家和广大师生批评指正、多提意见，并预致谢意。

李淑波

2011 年 6 月

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HISTOLOGY

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EMBROLOGY

HISTOLOGY

Chapter 1 INTRODUCTION

DEFINITION AND RESEARCH LEVELS

Histology is the study of the normal microstructures of the human body and of the relationship between structures and functions. In a sense, histology is just a microanatomy, from gross to microscopic structures. The human body is made up of cells, tissues, oranges and systems. **Cells** are the smallest structural and functional units of the human body. They consist of the cell-membrane, nucleus and cytoplasm. An adult contains about 1×10^{15} cells in the body. **Tissues** are made up of groups of cells and extracellular matrix which is produced by cells. Four fundamental tissues are recognized: epithelial tissue, connective tissue, muscular tissue, and nervous tissue. Most **organs** are formed by an orderly combination of several different kinds of tissues. The precise combination of these tissues allows the functioning of each organ and of the organism as a whole. **Systems** are formed by several organs with related functions.

Histology is a basic science to physiology, biochemistry, pathology and clinical medicine. Biochemistry deals with the chemical compounds and chemical processes in living things. Chemical molecules, however, do not float randomly in solution in the body. They are precisely organized inside the cells and tissues into discrete structures. Only after understanding of microstructures of the body, can you expound the functions of the different tissues. So, the development of histology further promotes the advance of physiology. An understanding of normal microstructures is a necessary prelude to the study of pathology. A thorough knowledge of histology is fundamental for them as future doctors.

HISTOLOGICAL TECHNIQUES

The development of histology depends mainly on the use of microscopes. Advances in chemistry, physiology, immunology, and pathology, and the interactions among these fields are essential for a better knowledge of tissue biology. This chapter discusses some of the more common methods used to study cells and tissues and the

principles involved in these methods.

Light Microscope

The resolution of light microscope is about 0.1 ~ 0.2 μm. The routine histological preparation for light microscope examination is a paraffin section. The procedures are as follows:

Obtaining the specimen

In general, tissues should be as fresh as possible. Human tissues or experimental animal tissues are obtained immediately after they have been death. The tissues taken are cut into small pieces called **tissue blocks** (no more than 1 cm^3 in size).

Fixation

Tissues should be rapidly put into the chemical fixative to preserve so that they have the same structure and molecular composition as it had in the body. One of the best fixatives is a buffered isotonic solution of 4% formaldehyde.

Dehydration and clearing

The fixed tissues are bathed successively in graded series of ethyl alcohol solution (usually from 70% to 100%). The alcohol is then replaced with a solvent miscible with the embedding medium. The solvent used is usually xylene. Infiltrated with xylene, the tissues generally become transparent (clearing).

Embedding

Tissue blocks impregnated with xylene are placed in melted paraffin in the oven. The tissue together with its impregnating paraffin gets hard after being taken out of the oven.

Sectioning

The hard tissue blocks are sectioned by a microtome to a thickness of 5 ~ 10μm. The sections are floated on water and transferred to glass slides to be stained.

Staining

To be studied in the microscope most sections must be stained. Most of dyes behave like acidic or basic compounds. Tissue components that stain more readily with basic dyes are called basophilia. Those with an affinity for acidic dyes are termed acidophilia. **Haematoxylin and eosin staining** (HE staining) is themost common. Haematoxylin (H) is a basic dye, and stains the nucleus, RNA-rich portions of the cytoplasm, etc. blue. Eosin (E) is an acidic dye, stains the most cytoplasm, collagen, etc. pink. There are some special stainings used in the different histological procedures. For example, silver nitrate stains neurons black called **argyrophilia**; aldehyde-fuchsin stains elastic fibers and the granules of mast cell purple called **metachromasia**, etc..

In addition to the routine paraffin sections, **frozen sections** may also be cut with a freezing microtome. Since preparing frozen sections does not subject tissues to dehydration, clearing and embedding, some chemical components and enzymes may be better preserved. **Smear preparations** are sometimes used for examination of blood or other secretions. **Stretched preparations** are usually used for examination of loose CT. **Ground sections** are sometimes used for examination of tooth or bone.

Electron Microscope

Transmission electron microscope

The transmission electron microscope permits a very high resolution about 0.1 ~ 0.2nm. It uses a beam of electrons with short wave-lengths in place of visible light. The electron beam can be deflected by electromagnetic lenses in a manner similar to light deflection in glass lenses. The magnified image so formed is made visible to the human eye by causing the electrons to project on to a fluorescent screen. To provide a good interaction between the specimen ad the electrons, electron microscope requires ultra-thin sections of about 50 ~ 70nm. The procedures involved in preparing sections for electron microscope are similar to those employed for light microscope. However, the sample of tissues must be much smaller about 1 cubic millimeter or less in size. Embedding is performed with a hard epoxy plastic. The blocks thus obtained are so hard that a special **ultramicrotome** using glass or diamond knifes are usually necessary to section them. The extremely thin sections are collected on small metal grids and stained with one or more heavy metal salts in order to increase structural contrast. The flow of electrons is impeded by those tissue elements which are stained with heavy metal salts. Consequently, very few electrons penetrate these areas to excite the underlying fluorescent screen. Such areas appear dark and are described as **electron dense** areas. Unstained areas, by contrast, appear electron-lucent.

Scanning electron microscope

A very narrow electron beam scans the surface of the specimen. As the electron beam bombards the surface of the specimen, secondary electrons are emitted from the surface and collected by a detector. The resulting signals from many points create a photograph on a cathode ray tube, revealing the three dimensional views of the surfaces of the cells, tissues, and organs.

Histochemistry and Cytochemistry

Histochemistry and cytochemistry combine histological and cytological methods with chemical, physical, biochemical or immunological methods and localize different substances, e. g. proteins, amino acids, nucleic acids, lipids, carbohydrates, i-

ons and enzymes, of tissues or cells in situ. Several procedures are used to obtain this type of information, most of them based on specific chemical reactions or on high-affinity interactions between macromolecules. These methods usually produce insoluble colored or electron-dense compounds.

General histochemistry

Some compositions in tissue sections react with certain chemical reagent to produce an insoluble colored or heavy metal depositor which is seen under a light or electron microscope. As an example of this, the **periodic acid-Schiff reaction** (PAS reaction) is the histochemical technique most extensively used to demonstrate polysaccharides, such as glycogen, in tissues and cells. In this reaction, the periodic acid oxidizes certain hydroxyl groups of the glucose in glycogen to aldehyde residues. The residues are then revealed by Schiff's reagent, which produces a magenta color complex in areas of the section with an accumulation of polysaccharides.

Immunohistochemistry and immunocytochemistry

For a highly specific interaction between an antigen and its antibody, immunohistochemistry and immunocytochemistry use labeled antibodies as specific reagents for identifying and localizing specific proteins and peptides (as antigens) in tissues and cells. In order to detect proteins and peptides in tissues and cells, specific antibodies are raised by certain immunizing animals with completely pure or synthetic antigens. The specific antibody is conjugated to fluorescein isothiocyanate, horseradish peroxidase and colloidal gold etc. the labeled antibody is incubated with antigen-containing tissue sections. The antibody binds to the antigen and the bound antibody is then washed out. The labeled antibody attached to the antigen site can be detected under the microscope.

In situ hybridization

The in situ hybridization is just the nucleic acid molecular hybridization which is a method using nucleotide probe to check target fragment of specific DNA or mRNA sequences directly in cells or tissue sections. Theoretically, this technique is based on the fact that labeled single-stranded fragments of DNA or mRNA containing complementary probes are hybridized to cellular DNA or mRNA in situ under appropriate conditions to form stable hybrids, in order to study the gene expression. The most commonly used radioactive labels are ^{3}H, ^{35}S and ^{32}P, while biotin and digoxigenin are the most widely applied nonradioactive reporter molecules.

Cell and Tissue Culture

Cell and tissue cultures are also termed in vitro. Live cells and tissues can be maintained and studied outside the body. Isolated cells or fragments of tissues or or-

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