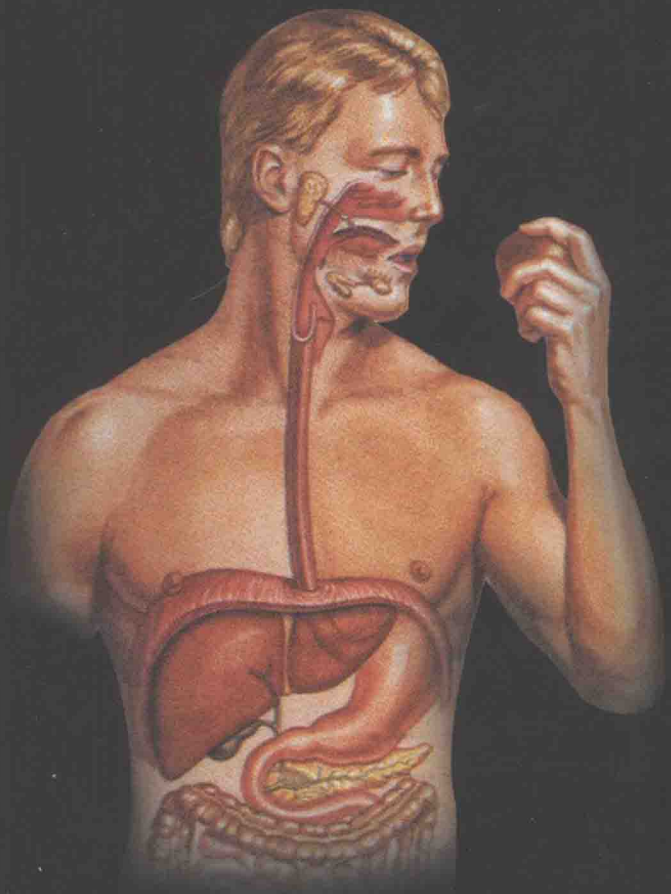
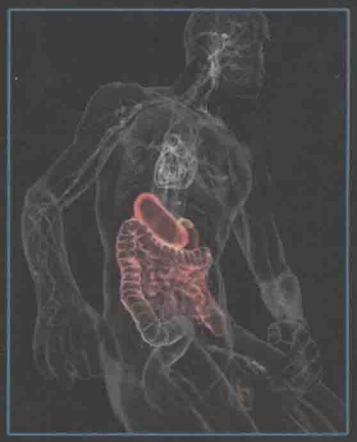
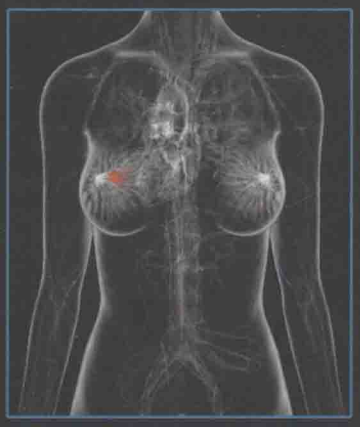
华侨华人留学生高等教育系列精品教材

Human Anatomy Textbook

Chief editors Sanqiang Pan Baogui Su







暨南大學出版社
JINAN UNIVERSITY PRESS

Human Anatomy Textbook

Chief editors Sanqiang Pan Baogui Su
主 编 潘三强 宿宝贵

暨南大學出版社
JINAN UNIVERSITY PRESS
中国·广州

图书在版编目（CIP）数据

人体解剖学 = Human Anatomy Textbook：英文/潘三强，宿宝贵主编．—广州：暨南大学出版社，2010.3

ISBN 978-7-81135-467-6

Ⅰ.①人… Ⅱ.①潘…②宿… Ⅲ.①人体解剖学—高等学校—英文 Ⅳ.①R322

中国版本图书馆 CIP 数据核字（2009）第 030083 号

出版发行：暨南大学出版社

地　址：中国广州暨南大学
电　话：总编室（8620）85221601
　　营销部（8620）85225284　85228291　85220693（邮购）
传　真：（8620）85221583（办公室）　85223774（营销部）
邮　编：510630
网　址：http://www.jnupress.com　http://press.jnu.edu.cn

排　版：广州市天河星辰文化发展部照排中心
印　刷：广州市天河区智印印刷厂

开　本：787mm×1092mm　1/16
印　张：15.375
字　数：266 千
版　次：2010 年 3 月第 1 版
印　次：2010 年 3 月第 1 次

定　价：58.00 元

Human Anatomy

Chief editors

Sanqiang Pan (Medical College of Jinan University)

Baogui Su (Medical College of Jinan University)

Vice editors

Yiwen Ruan (Medical College of Jinan University)

Xin He (Medical College of Beihua Univeristy)

Guozhong Tian (Medical College of Jiamusi University)

Yi Qin (Ningxia Medical University)

Editorial staffs

Jinhao Sun (Medical College, Shangdong University)

Zhenquan He (Guangzhou University of Chinese Medicine)

Guoliang Chu (Medical School, Sun-Yat Sen University)

Lepeng Hong (Guangzhou Medical College)

Preface

It is not unusual that students complain about the complexity of terminology of the numerous structures in human anatomy. The purpose of this book is to describe human structures in a concise manner, with the intention to provide a basic knowledge of anatomy for students in health science, especially those who are studying pharmacy/pharmacology, biomedical science or community medicine.

Some simplified tables and a large number of color figures are used in this textbook to help the students to understand better the various structures of the human body. The terms of relatively important or major structures are printed with characters in bold, and the origins and meanings of some anatomical terms are also mentioned to facilitate comprehension. Cytological and histological aspects are also included throughout the text but limited to certain specific body parts, mainly to help the students to better understand the disease processes. As structure and function are closely related and complementary to each other, emphasis is also given to human body function where appropriate. References to anatomy literature are listed so that students can acquire a deeper knowledge of an area of interest, should they so desire. Our ultimate goal is to help students to understand how human body works and how to utilize the knowledge of anatomy for improving as well as maintaining health.

This book got the support from the grant of Overseas Chinese Affairs Office of the State Council and Jinan University in partnership with the foundation of Chinese-English bilingual teaching model courses from Ministry of Education of P. R. C. . We thank Dr. Zhong wenyi for his critical reading of the manuscript.

I welcome your suggestions for improvements in the next edition.

Sanqiang Pan Baogui Su
November 2009

Contents

Part One Introduction

Ⅰ. What's Anatomy

Human anatomy (人体解剖学) is the science which studies the location, shape and structure of human organs. The word "anatomy" comes from the Greek, "ana-" meaning "up or through" and "tome" means "cutting". Human body has undergone millions of years of evolution. Structure and function of the body are closely related to each other. Both, capable of influencing one another.

Human organ systems work together to perform all the basic life processes and advanced activities, such as: movement, respiration, learning and thinking. The organ systems include nine systems: locomotor, digestive, respiratory, urinary, reproductive, endocrine and nervous systems, angiology and sensory organs. An organ system is a group of organs integrated by structure and function to carry out one or more general processes.

The whole body is organized by systems, systems by tissues, tissues by cells. The cell is the basic unit of living body. The human body develops from a single cell-zygote, which will be eventually divided into 75 trillion cells of 200 different kinds.

Ⅱ. Anatomical Position, Terms and Planes

All anatomical descriptions are expressed based on the anatomical position. The anatomical position (解剖学姿势) refers to the human body which stands erect facing forward with hands at the sides and palms forward.

Terms are illustrated in Table 1.1 and Figure 1.1.

The main use of anatomical planes is to describe sections and images of the body. There are sagittal, coronal and horizontal planes (Figure 1.2). The sagittal plane (矢状面) is the vertical plane which passes through the body parallel to the median plane. The median plane is the vertical plane passing through the midline of the body-dividing it into equal right and left halves. The coronal plane (frontal plane, 冠状面) is the vertical plane passing through the body at right angles to the median plane and divides the body into anterior and posterior parts. The horizontal plane (transverse plane, 水平面) is the plane passing through the body horizontally and divides the body into superior and inferior parts.

Table 1.1 Anatomical Terms

Term	Meaning
anterior (ventral)	nearer to front
posterior (dorsal)	nearer to back
superior	nearer to head
inferior	nearer to feet
medial	nearer to median plane
lateral	father from median plane

Table 1.1 (Continued)

proximal	nearer to trunk or point of origin
distal	farther from trunk or point of origin
internal	nearer to the cavity of a hollow organ
external	farther from the cavity of a hollow organ
superficial	nearer to the surface
deep	farther from surface

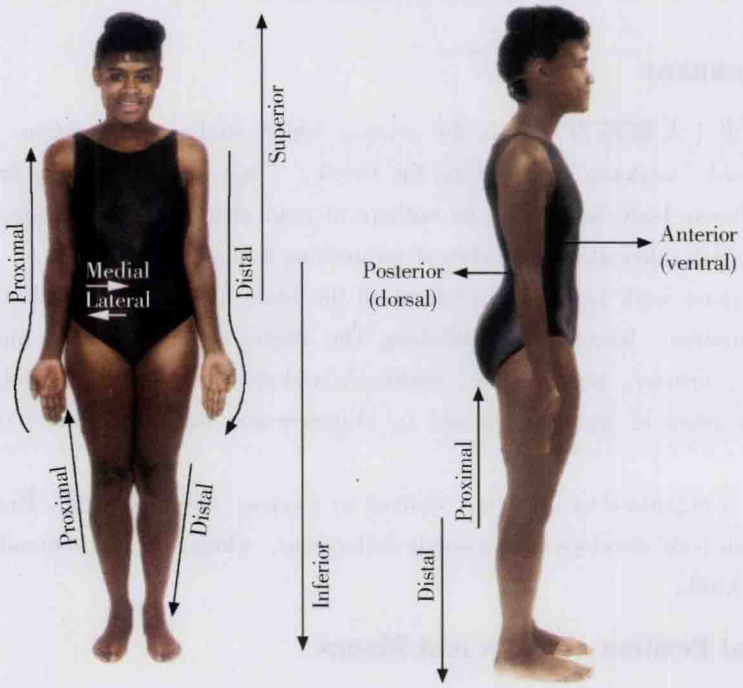


Figure 1.1 Anatomical Position and Term

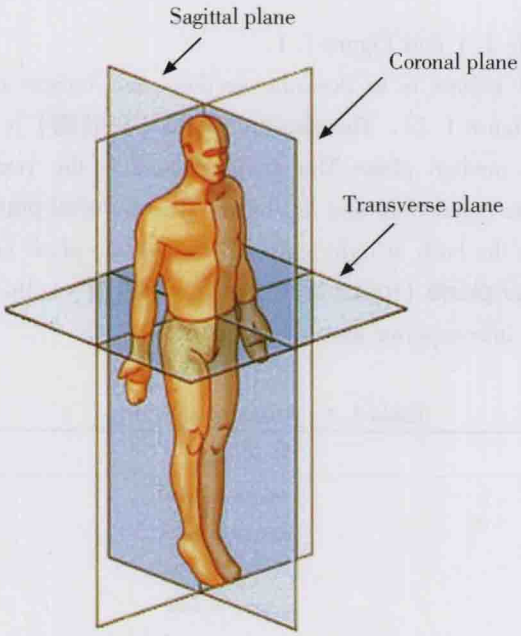


Figure 1.2 Anatomical Planes

Part Two Cells and Tissues

Section One Cells

Cells are the smallest structural and functional units of living things and body. Human body consists of many kinds of interdependent cells with different shapes, sizes and functions. Such as, a small lymphocyte is 6μm in diameter, and an ovum is 120μm.

Ⅰ. Cellular Structure and Function

In general, a cell consists of a nucleus, cytoplasm and cell membrane. The nucleus is suspended in the semifluid cytoplasm and surrounded by the cell memhrane.

1. Cell membrane

The cell membrane (plasma membrane, 细胞膜) separates the intracellular structures from the external environment. Its primary function is to control the passage of substances into or out of the cell, and helps to maintain intracellular homeostasis.

(1) Structure of cell membrane. The plasma membrane and membranes of certain organelles have the same structural components (Figure 2.1). According to the fluid-mosaic model (液态镶嵌模型), a membrane consists of a semifluid lipid matrix in which proteins are embedded to form a mosaic. The lipid matrix is made of phospholipids arranged in two layers. The polar hydrophilic phosphate regions of the molecules are oriented toward the extracellular and intracellular surfaces, which are exposed to aqueous fluids. The nonpolar hydrocarbon ends point toward each other in the interior of the membrane. The lipid matrix also contains cholesterol, which contributes to the fluidity of the membrane at body temperature. Membrane proteins are interspersed among the lipids. Integral proteins extend partially or completely through the lipid layers, and peripheral proteins are loosely attached to membrane surfaces. The proteins perform many functions. Some proteins are receptors, some are enzymes, some are involved in movements of substances. Sugars combine with some membrane proteins to form glycoproteins and with some membrane lipids to form glycolipids. Glycoproteins and glycolipids cover about 7 percent of a cell's extracellular surface. These sugary molecules act as cell recognition sites, which are important in cell-to-cell interactions. They also form binding sites that allow various chemical substances such as hormones to attach to the cell's surface and influence cell function.

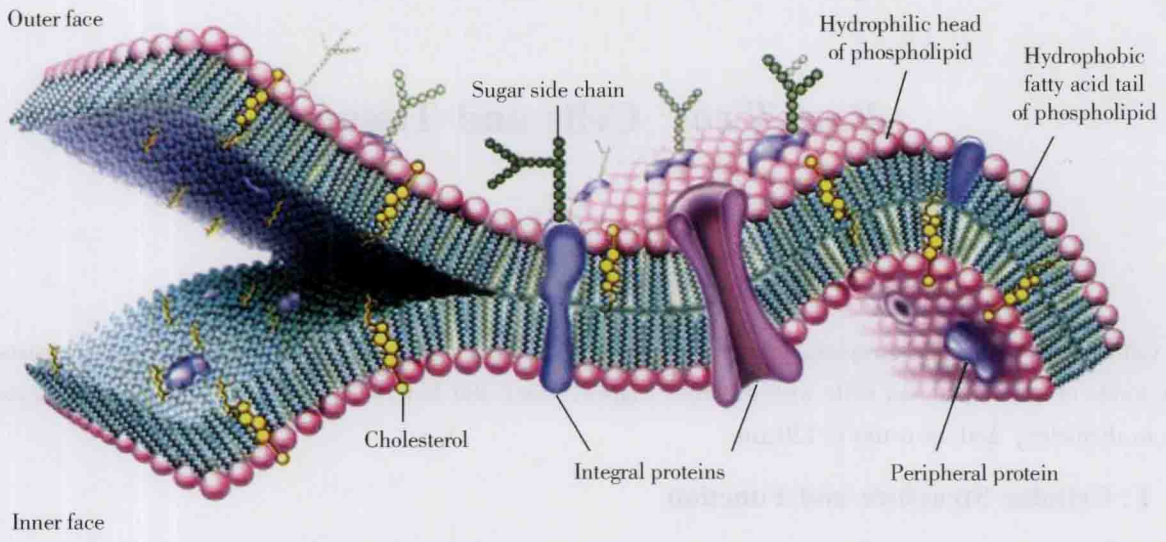


Figure 2.1 Cell Membrane (Fluid-mosaic Model)

(2) **Manners of movement of materials across membrane**. A living cell is a dynamic entity with substances constantly moving in and out of it across the plasma membrane. The manner of movement of an ion or molecule across a membrane is determined by a combination of the following factors: particle size, electrical charge, relative concentrations of the substance on the two sides of the membrane, lipid solubility and the availability of carrier molecules in the membrane. The mechanisms by which substances move across membranes include passive and active transport processes. **Passive transport processes (被动转运过程)** involve movements of substances down a concentration gradient, that is, from a region of higher concentration to a region of lower concentration, without cells supplying energy. Passive processes include simple diffusion, facilitated diffusion and osmosis. In contrast, **active transport processes (主动转运过程)** require energy from ATP to move substances across the cell membrane. These processes include active transport, endocytosis and exocytosis.

Simple diffusion (单纯扩散) is the net movement of molecules from their region of higher concentration to their region of lower concentration (Figure 2.2). Only O_2, CO_2 and lipid-soluble small molecules can enter and diffuse throughout the membrane by the simple diffusion.

Facilitated diffusion (易化扩散) is the diffusion of a substance across a membrane with the assistance of a carrier molecule (Figure 2.3). It includes two types: ①Glucose and some amino acids and vitamins enter cells by membrane-bound proteins, which bind to one or a few specific molecules and assist in their movement across the membrane. ②Some ions such as K^+, Na^+, Ca^{2+} pass through the cell membrane through special ion channels.

Water passes through cell membranes rapidly in both directions by **osmosis (渗透压)**, the diffusion of water across a selectively permeable membrane from a region of higher water concentration to one of lower water concentration.

In contrast to the passive processes described above, **active transport (主动转运)** moves substances against concentration gradients from regions of lower to higher concentration. It requires the cell to use energy from ATP (Figure 2.4). In fact, cells may spend as much as half of the energy they use in a resting state for active transport. Active transport requires membrane proteins that are both enzymes and carriers. Carriers have

specificity in that each binds to and transports a single substance or a few closely related ones. Such as chloride ions, calcium ions, sodium-potassium pumps transport ions through the active transport. The active transport is the most important movement of materials across membrane.

Endocytosis（入胞） is the process by which cells bring macromolecules, large particles and even small cells into the cell from outside by engulfing them with their cell membrane. There are three types of endocytosis: **phagocytosis（吞噬）**, **pinocytosis（吞饮）**, and **receptor-mediated endocytosis（受体介导的胞吞）** (Figure 2.5). Phagocytosis is the process by which cells use pseudopods to surround and engulf particles of organic matter (such as bacteria). Phagocytic cells surround their victim with pseudopods, which join and fuse. After the inner membrane of the pseudopods has surrounded the ingested particle, it pinches off from the cell membrane. The ingested particle is now contained in a vesicle. The vesicle will subsequently fuse with a lysosome, and the particle will be digested by lysosomal enzymes. The phagocytosis serves to protect the body from invading microorganisms and to remove extracellular debris. Pinocytosis is a process in which the cell membrane furrows inwards, instead of extending outward with pseudopods. It's concerned with the uptake of solutes and single molecules such as proteins. The extracellular molecules must bind to very specific receptor proteins in the cell membrane, this process is known as receptor-mediated endocytosis.

The process opposite to endocytosis is exocytosis. The **exocytosis（胞吐）** is a process by which cellular products are secreted into the extracellular environment. In the process of exocytosis, these secretory vesicles fuse with the cell membrane and release their contents into the extracellular environment. For example, nerve endings release their chemical neurotransmitters in this manner.

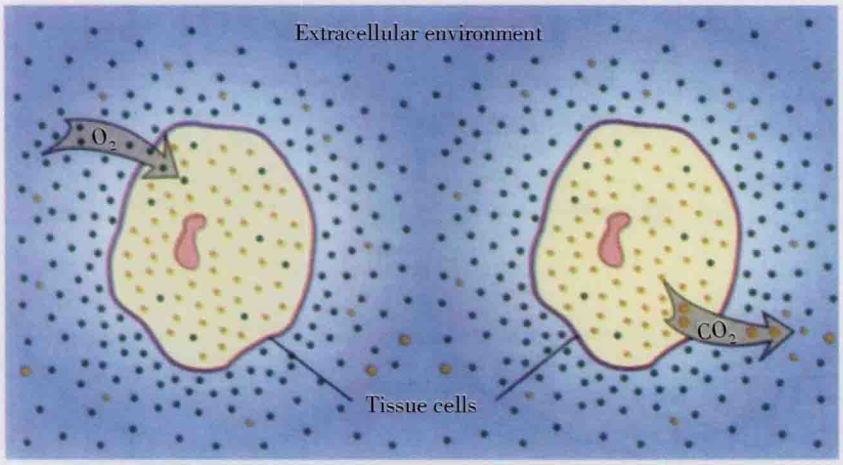


Figure 2.2 Simple Diffusion

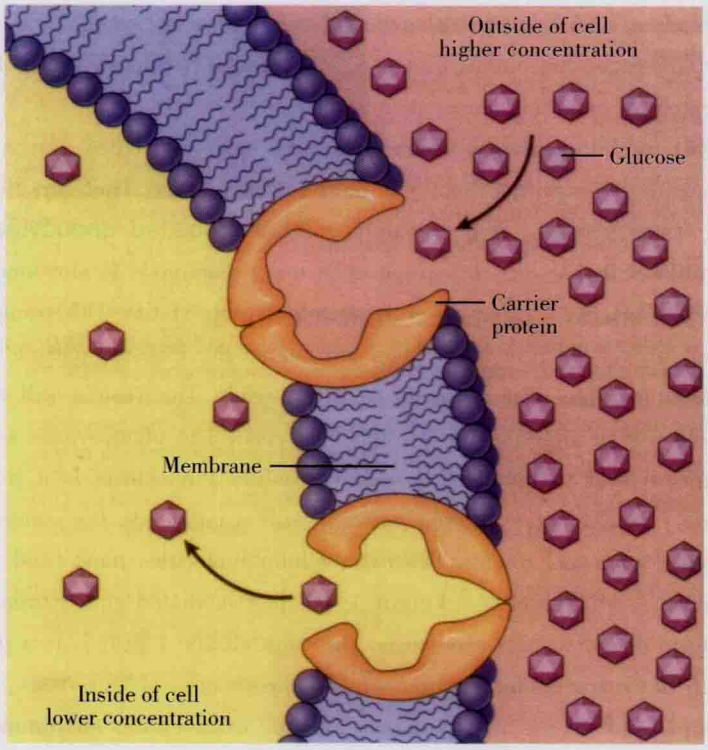


Figure 2.3 Facilitated Diffusion

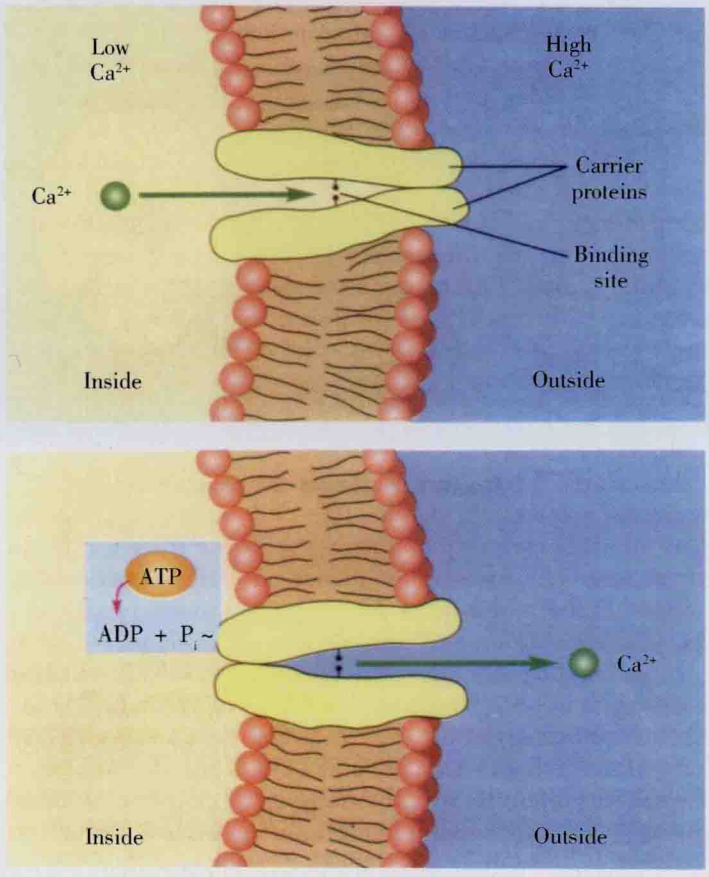


Figure 2.4 Active Transport

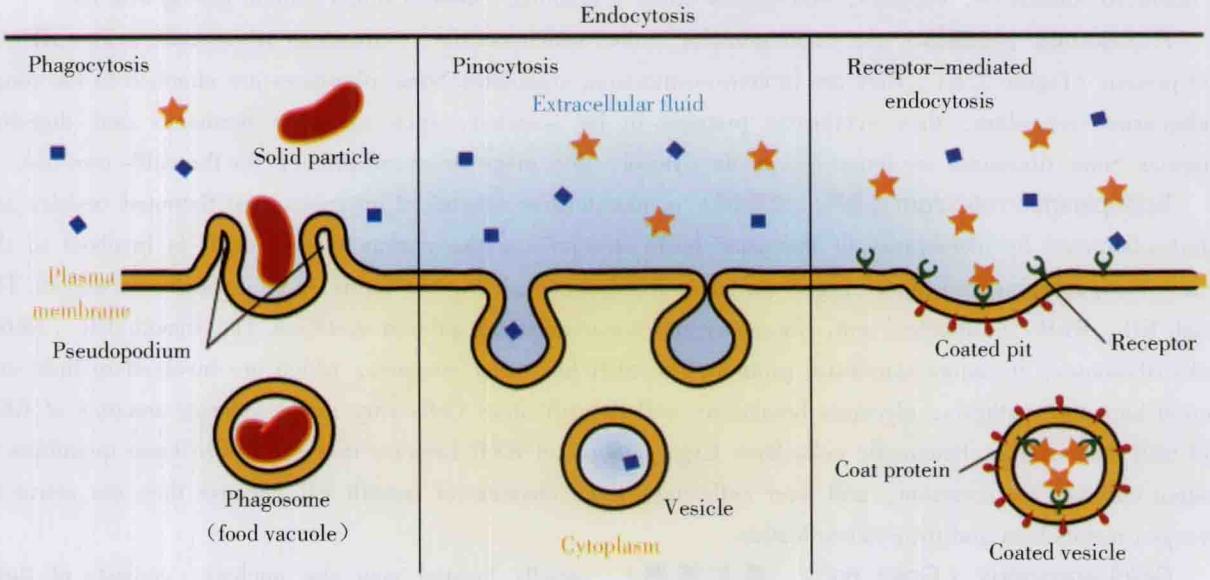


Figure 2.5 Endocytosis

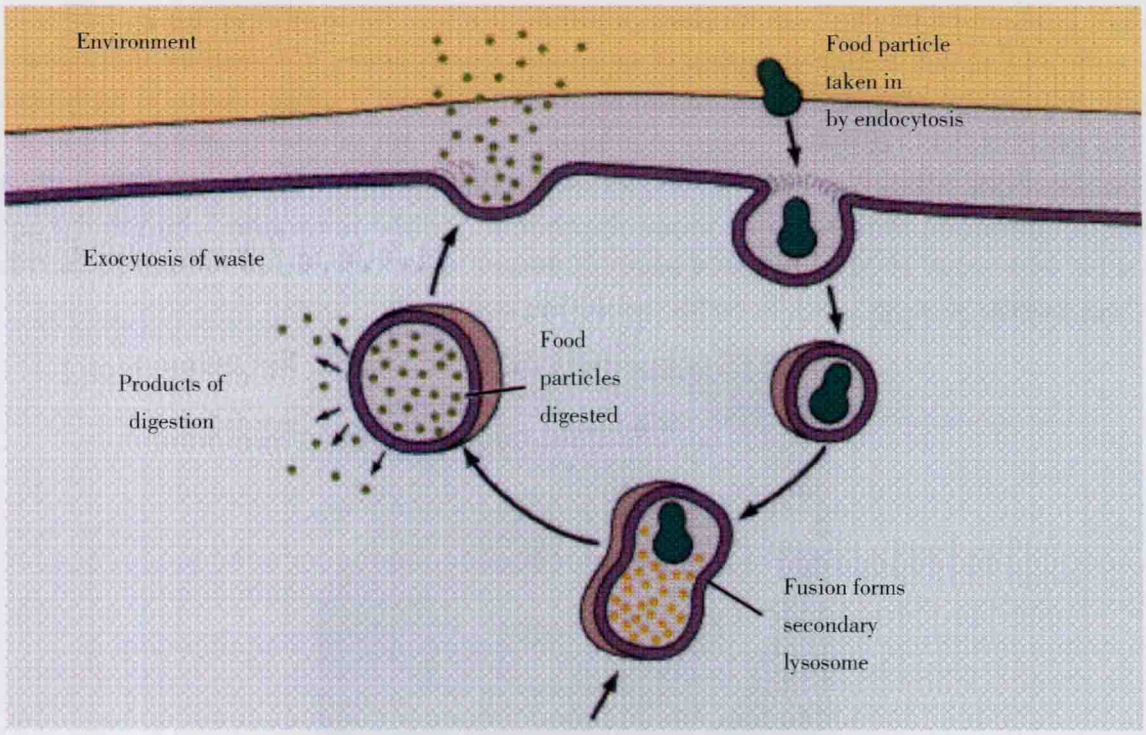


Figure 2.6 Exocytosis

2. Cytoplasm (protoplasm)

The **cytoplasm (细胞质)** is a fluid, jellylike substance between the cell membrane and the nucleus. Cytoplasm contains many discrete organelles, which are ribosomes, endoplasmic reticulums, Golgi apparatus, mitochondria, lysosomes, peroxisomes, microtubules, microfilaments and centrioles, et al. (Figure 2.7). Cytoplasm also contains small particles suspended in a thick fluid called **cytosol (细胞溶质)**. Cytosol consists

of dissolved substances, enzymes, and several kinds of granules—most of which contain glycogen or fat.

Ribosomes (核糖体) are small granular bodies which consist of ribosomal ribonucleic acid (rRNA) and protein (Figure 2.8). They are protein-synthesizing organelles. Some ribosomes are attached to the rough endoplasmic reticulum, they synthesize proteins to be secreted, such as some hormones and digestive enzymes. Some ribosomes are found free in the cytosol, they make structural proteins for the cell's own use.

Endoplasmic reticulum (ER, 内质网) is an extensive network of interconnected flattened vesicles and tubules bounded by membranes of the same basic structure as the plasma membrane. It is involved in the synthesis, packaging and processing of various cell substances. It has two forms, called rough and smooth. The rough ER (RER) is attached with ribosomes and concerned with protein synthesis. The smooth ER (SER) lacks ribosomes, it cannot synthesize proteins. The SER has many enzymes, which are involved in lipid and steroid hormone synthesis, glycogen breakdown and detoxification. Cells vary in the relative amounts of RER and SER they contain. Pancreatic cells have large amounts of RER because they synthesize large quantities of protein enzymes for secretion, and liver cells have large amounts of smooth ER because they are active in glycogen metabolism and drug detoxification.

Golgi apparatus (Golgi body, 高尔基器), usually located near the nucleus, consists of three compartments: a stack of curved, flattened cisternae, numerous small vesicles, and a few large condensing vacuoles (Figure 2.9). Small vesicles contain newly synthesized protein, and condensing vacuoles carry the processed protein and finally fuse with the plasma membrane to release the secretory product by exocytosis. The Golgi is the packing and shipping department of the protein-secretory factory. It is important in the synthesis of secretory glycoproteins and proteoglycans and also involved in packaging of certain enzymes to the lysosomes.

The **mitochondrion (线粒体)** consists of an outer membrane and an inner membrane (Figure 2.10). The inner membrane folds to form cristae, which are studded with adenosine triphosphate (ATP) synthase and a variety of cytochromes. Mitochondria are usually described as "cellular power plants" because they generate most of the cell's supply of ATP, used as a source of chemical energy. They are more numerous in cells that need large amounts of energy, such as cardiac and striated muscle cells.

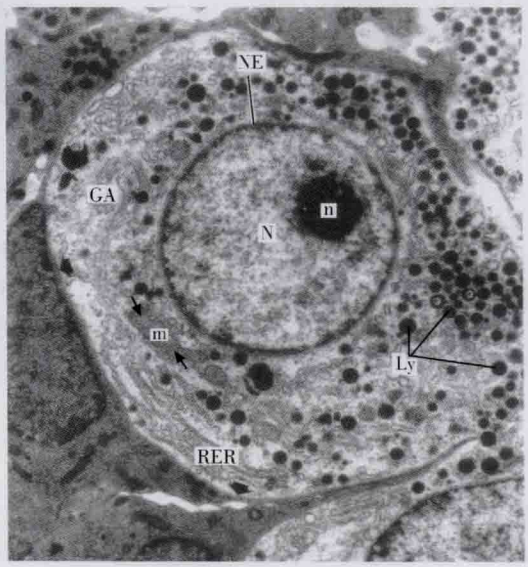


Figure 2.7 Cell Ultrastructure

(GA: Golgi apparatus; Ly: lysosomes; m: mitochondrion; N: nucleus; n: nucleolus; NE: nuclear envelope; RER: rough endoplasmic reticulum)

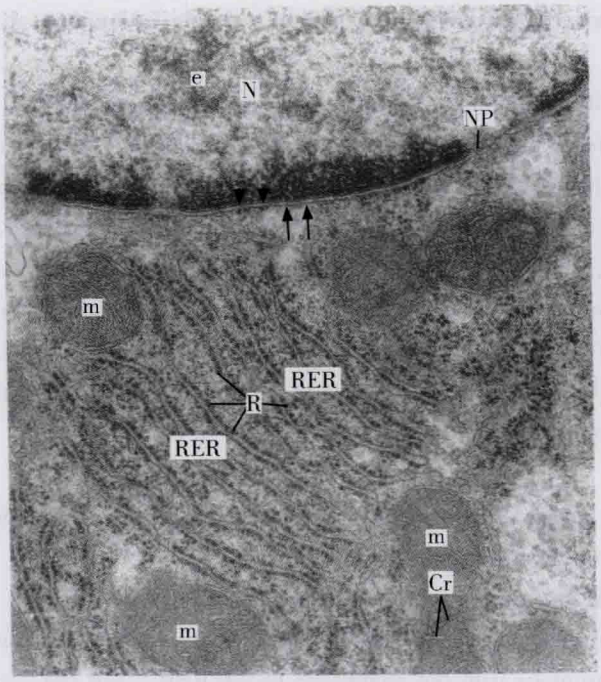


Figure 2.8 Endoplasmic Reticulum and Ribosomes

(Cr: cristae of mitochondrion; m: mitochondrion; N: nucleus; NP: nuclear pore; R: ribosomes; RER: rough endoplasmic reticulum)

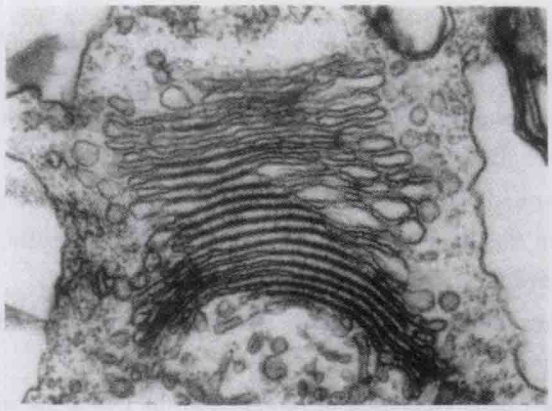


Figure 2.9 Golgi Apparatus

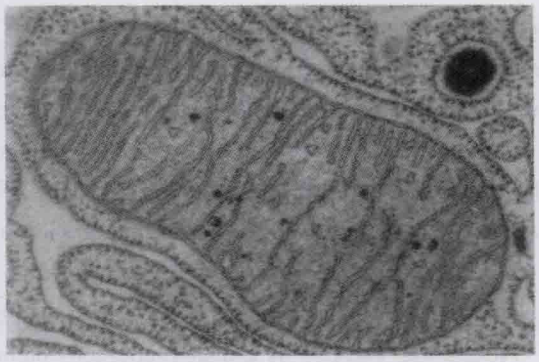


Figure 2.10 Mitochondrion

Lysosomes (溶酶体) are spheric, membrane-limited vesicles that contain more than 50 enzymes (Figure 2.7). They are the cellular digestive system. Lysosomal enzymes are most active at an acid pH. Newly formed lysosomes, those that have pinched off from the ends of the Golgi cisternae, are called **primary lysosomes (初级溶酶体)** and contain all the enzymes that are mostly inactive. Primary lysosomes fuse with the membrane of the structure that contains the material to be digested, thus forming the **secondary lysosome (次级溶酶体)**. When the lysosomal enzymes mix with the digested materials, they become active. Hydrolytic breakdown of the contents of secondary lysosomes often produces a debris-filled vacuole called the **residual body (残余体)**. Residual bodies may remain in cells for the life of the cell.

Peroxisomes (过氧化物酶体) are small, membrane-limited spherical bodies that contain oxidative enzymes (Figure 2.11). In most animals (not humans), they are distinguishable from lysosomes by an

granular nucleoid of urate oxidase. Peroxisomes function in hydrogen peroxidase metabolism and the β oxidation of fatty acids.

Microtubules（微管） are the thickest cytoskeletal components （Figure 2. 12）. They are fine tubular structures, whose walls consist of tubulin heterodimers. Microtubules are important in the maintenance of cell shape, axoplasmic transport in neurons, cell movement and movement of chromosome during mitosis.

Microfilaments（微丝） are the thinnest cytoskeletal components （Figure 2. 13）. They consist of actin proteins. They are contractile, but the contraction usually must interact with myosin.

Centrioles（中心粒） are a pair of short rod-like bodies, which are always oriented at right angles to each other in nondividing cells （Figure 2. 14）. Each centriole is a cylindric group of microtubules, containing 9 microtubule triplets in a pinwheel array. Centrioles are the structural organizers of the cell. Centriole duplication is a prerequisite for cell division.

3. Nucleus

The **nucleus（核）** is a spherical or oval body near the centre of a cell. It consists of a nuclear envelope, chromatin, nucleoplasm and one to several nucleoli （Figure 2. 15）.

A **nuclear envelope（核膜）** consists of a double membrane with a narrow intermembrane space called the **perinuclear cistern**（perinuclear space，**核周池，核周隙**）. In the interphase cell, the outer membrane of the nuclear envelope is continuous with the membrane of the RER, and the perinuclear space is continuous with the cisternal space of the RER. Ribosomes are often present on the cytoplasmic side of the nuclear envelope. There are many openings in the nuclear envelope called the **nuclear pores（核孔）**, which are channels for the movement of molecules between the nucleus and cytoplasm, such as nucleic acids and proteins.

Chromatin（染色质） consists of DNA and associated histone and nonhistone proteins and is intensely basophilic. It has two types: **heterochromatin（异染色质）** and **euchromatin（常染色质）**. The heterochromatin is highly condensed chromatin and densely stained. The euchromatin is a dispersed form and lightly stained. The euchromatin is indicative of active chromatin, i. e. , chromatin that is stretched out so that the genetic information in the DNA can be read and transcribed. During mitosis, chromatin is highly condensed and organized into **chromosomes（染色体）**, which are the most highly condensed form of chromatin. The function of DNA is to contain genetic information and control the synthesis of proteins.

Nucleoplasm（核质） is the matrix in which the other intranuclear components are embedded. It contains enzymatic and nonenzymatic proteins, ions, metabolites and water.

Nucleolus（核仁） is a nonmembranous bound shaped body composed of protein and nucleic acids within the nucleus. It is the site of ribosomal RNA synthesis and initial ribosomal assembly. The nucleolus disappears in preparation for mitosis and reappears after mitosis is completed.

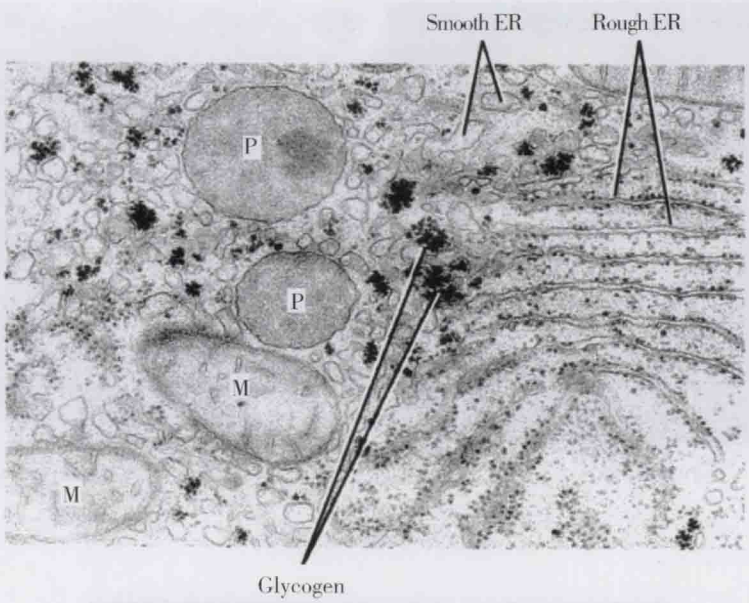


Figure 2. 11 Peroxisomes

(P: peroxisome; M: mitochondrion)

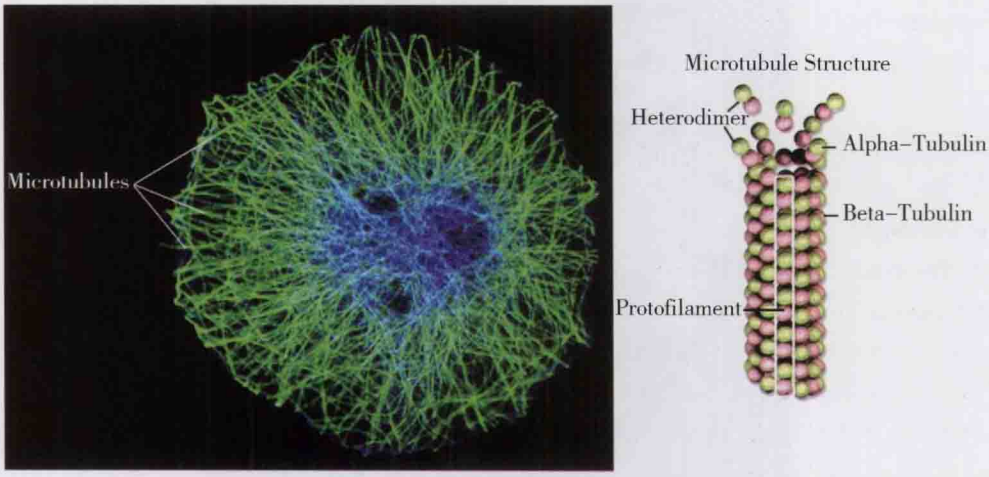


Figure 2. 12 Microtubules

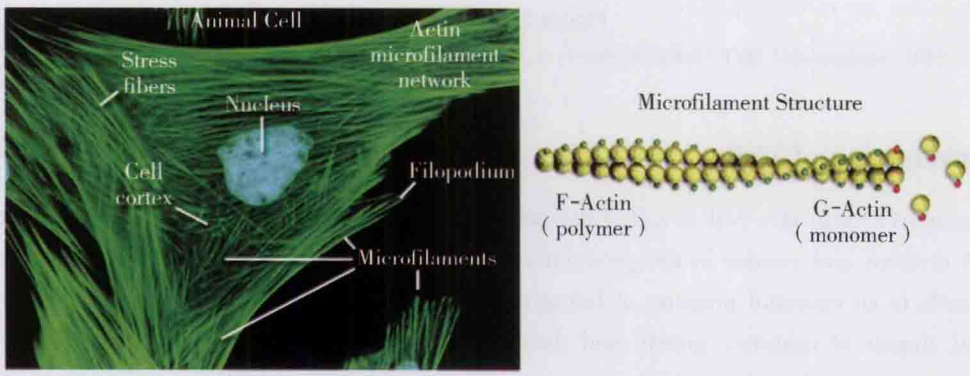


Figure 2. 13 Microfilaments