SYNOPSIS OF ENGLISH FOR PRE - CLINICAL MEDICINE

基础医学英语学习概要

主　　编　冯志强　李著华

副 主 编　吴绍华　肖洪文　肖顺汉　税青林　龙汉安

英语主审　林家修

医学主审　刘远厚

编委名单　税青林　肖洪文　吴绍华　冯志强　李　洪
何　涛　邬于川　李著华　龙汉安　王光西
肖顺汉

四川科学技术出版社

书　　名: 基础医学英语学习概要

作　　者：　冯志强 李著华

出 版 社：四川科学技术出版社

出版时间：2003-1-1

ISBN：7-5364-5331-0/H31

定　　价: 26.00

前　　言

编写本书的目的,是帮助医学生学习专业英语,以提高对外交流和直接吸纳外国先进医学知识的能力。

本书由长期工作在教学一线的教授和副教授,根据各专业教学实际,参考国内外的教科书编写而成。全书内容包括医学生物学、解剖学、组织学、生理学、生物化学、分子生物学、免疫学、病理生理学、病理学、寄生虫学和药理学等 11 部分,基本涵盖各专业教学大纲所要求的知识要点。通过本书的阅读,不但可以提高专业英语水平,亦可加深对各专业知识的理解。因此,本书既适用于高等医学院校本、专科学生,亦适用于相应专业的硕士研究生或其他医务人员学习和参考。

本书编写工作除编委外,胡兴宇、余崇林、王继丰、袁琼兰,赵春玲、盘强文、张春来,肖秀丽和陈美娟、秦大莲、李小兵、赵志明等分别参加了解剖学、生理学、病理学和药理学中个别章节的编写。

本书编写过程中,参考和引用了国内外有关书刊中的相应内容,在此,特向原著者表示感谢。同时,本书编写和出版过程中,得到泸州医学院和四川科学技术出版社有关领导的大力支持,在此一并致谢。

由于我们的水平有限,书中难免有错漏之处,请使用者不吝赐教与斧正。

编　　者

2003 年 8 月

Contents

Part I Cell and Inheritance

Chapter 1 The Molecules of Cell

On molecular scale, many of life' molecules are gigantic in fact. Biologists call them macromolecules. Protein, one class of macromolecules, may consist of thousands of covalently connected atoms. A second class is nucleic acids, one of which is DNA. A third class of macromolecules is made up of carbohydrates - specifically, a group of large carbohydrates called polysaccharides. Lipids, including the fats, comprise a diverse fourth group of large organic molecules important in cells.

Proteins

Proteins are involved in cellular structure, movement, defense, transport, and communication; and, as enzymes, they regulate chemical reactions. Proteins are the most structurally and functionally diverse of life's molecules. Their diversity is based on different arrangements of amino acids. Each amino acid contains an amino group, a carboxyl group, and an R group. The R groups in proteins distinguish 20 different amino acids, each with specific properties. Cells link amino acids together by dehydration synthesis, the bonds between amino acid monomers are called peptide bonds. Amino acid chains are called polypeptides. A protein consists of one or more polypeptide chains folded into a unique shape that determines the protein's function. A protein loses its specific functions when its polypeptides unravel. A protein primary structure is the specific sequence of amino acids forming its polypeptide chains. A protein's secondary structure is the coiling or folding of its polypeptides. Secondary structure includes helical coiling and pleated - sheet folding, stabilized by hydrogen bonds between amino acids. Tertiary structure is the overall three - dimensional shape of a polypeptide, resulting from interactions between R groups. A protein's quaternary structure results from bonding interactions among its polypeptide subunits.

Nucleic Acids

The nucleic acids are polymers that serve as the blueprints for proteins. There are two types: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). The genetic material that organisms inherit from their parents consists of DNA. Within the DNA are genes, specific stretches of the molecule that program the amino acid sequences (primary structure) of protein. In determining primary structure, genes determine the specific three - dimensional structures and therefore the functions of protein. Thus, through the actions of protein, DNA controls the life of the cell and the organism. DNA works through an intermediary - RNA. DNA's information is transcribed into RNA, which is then translated into the primary structure of proteins .

The monomers of nucleic acids are nucleotides . Each nucleotide is composed of a sugar, a phosphate, and a nitrogenous base . DNA has the nitrogenous bases adenine (A) , thymine (T) , cytosine (C) , and guanine (G) . RNA also has A, C, and G, but instead of thymine has uracil (U) . RNA usually consists of a single polynucleotide strand, but DNA is a double helix, in which two polynucleotides wrap around each other . The nitrogenous bases protrude from the two sugar - phosphate backbones into the center of the helix . There they always pair up : A pairs with T, and C pairs with G .

Carboydrates

Carbohydrates range from small sugars to large polysaccharides, which are macromolecules . A monosaccharide, or single sugar, typically has a formula that is a multiple of CH_2O and contains hydroxyl groups and a carbonyl group . The monosaccharides glucose and fructose, both with the formula $C_6H_{12}O_6$, are isomers, that is, they contain the same atoms but in different arrangements, and thus they have different properties . Monosaccharides are the fuels for cellular work . . Monosaccharides can join to form disaccharides, such as sucrose (table sugar) . High sugar consumption can cause tooth decay and may be associated with poor diet . Polysaccharides are polymers of hundreds or thousands of monosaccharides linked by dehydration synthesis . Starch and glycogen are polysaccharides that store sugar for later use . Cellulose is a polysaccharides that forms plant cell walls .

Lipids

Lipids, diverse compounds composed largely of carbon and hydrogen, are not true polymer . They are grouped together mainly because they do not mix with water . Fats, also called triglyceriders, are lipids whose main function is energy storage . A triglyceride molecule consists of glycerol linked to three fatty acids . The fatty acids of unsaturated fats such as plant oils contain double bonds, which prevent them from solidifying at room temperature . Saturated fats, such as those in lard, lack double bonds and are solid . Other lipids include phospholipids (found in cell membranes), waxes (which form waterproof coatings), and steroids (including sex hormones) . Use of synthetic variants of the male sex hormone, called anabolic steroids, can cause serious health prolems .

Chapter 2 Cell Structure and Function

Prokaryotic and Eukaryotic Cells

Two kinds of structurally different cells have evolved over time . Bacteria consists of prokaryotic cells, whereas all other forms of life are composed of eukaryotic cells .

Prokaryotic Cell: A prokaryotic cell (Greek pro, before, and karyon, kemel) lacks a nucleus; its DNA is coiled into a nucleoid (nucleuslike) region. Because no membrane surrounds the nucleus region, DNA is in direct contact with the rest of the cell contents. Under the direction of the DNA, ribosomes assemble amino acids into polypeptides, the polymer that make up proteins. DNA controls all cells by using RNA intermediariers to specify what proteins are made.

Bacterial cells are said to be prokaryotic because they do not have a nucleus. A plasma membrane encloses the cytoplasm of the bacterial cell. Surrounding the plasma membrane of most bacteria is a fairly rigid, chemically complex bacterial cell wall. The wall protects the cell and helps maintain its shape. In some bacteria, another layer, a sticky outer coat called a capsule, surrounds the cell wall and further protects the cell surface. Capsules also help glue some bacteria to surfaces.

Eukaryotic Cell: Outerside the realm of bacteria, all cells of all organisms - from the diatoms of phytoplankton to polar bears and peach trees and puffball mushrooms - are eukaryotic. Only eukaryotic cells have a profusion of organelles. Organelles are membranous sacs, envelopes, and other compartmented portions of the cytoplasm. The most conspicuous organelle is nucleus. (Hence the name eukaryotic, which means "true nucleus.")

Many of the chemical activities of cell - activities known collectively as cellular metabolism - occur in the fluidfilled spaces within membranous organelles. These spaces are important as sites where specific chemical conditions are maintained, conditions that vary from one organelle to another. Metabolic processes that require different conditions can take place simultaneously in a single cell because they occur within separate organelles. For example, besides the membranous organelles, eukaryotic cells have many thousands of ribosomes, either "free" in cytoplasm or attached to certain membranes. They also have a cytoskeleton, an internal network of protein filaments.

The Nucleus

Perhaps the most prominent structure in most cells is the nucleus. It also plays a central role in the life of the cell in that it is involved in critical processes, such as reproduction, and the regulation of virtually everything the cell does. The nucleus exerts its control by directing the synthesis of proteins that serve as enzymes, chemical messengers, or other active molecules.

Nuclear Envelope: The outermost part of the nucleus has two lipid bilayers, one wrapped around the other. They completely surround the nucleoplasm, which is the fluid portion of the nucleus. This double - membrane system is the nuclear envelope. As is true of all cell membranes, its lipid bilayers act as a barrier to water - soluble substances. In this case, clusters of membrane proteins span both bilayers, forming pore complexes. The pore complexes allow ions and small molecules to enter and leave the nucleus - but they selectively control the passage of larger molecules and particles. For example, they permit ribosomal subunits to pass into the cytoplasm, but they restrict enzymes of the nucleus and the cytoplasm to their respective compartments in the cell.

The innermost surface of the nuclear envelope has attachment sites for tiny filaments that help organize the DNA. Attached to the outermost surface is ribosomes, which take part in protein synthesis.

Nucleolus: Within each nucleus is a small structure called the nucleolus, a darkstaining body containing RNA, DNA, and proteins. Most nuclei contain only one nucleolus, but some kinds have more. The job of the nucleolus is to synthesize ribosomes. An actively growing cell can produce an astounding 10,000 ribosomes per minute.

Chromatin: Inside the nucleus is a fluid matrix in which a number of different types of bodies are suspended. When cells are appropriately stained, a netlike structure becomes visible within the nucleus. This material is called chromatin (from Greek: chromo, color) because of its affinity for the stains. At a certain period in the cell's cycle, the chromatin shortens and thickens and forms chromosomes, the structures that include sequences of genes. ① Functional and Nonfunctional Chromatin: Some chromatin is effectively insert. This is known as heterochromatin as compared with active chromatin or euchromatin. As is seen by electron microscopy heterochromatin has a denser pattern of chromatin fibrils. It can also be differentiated by staining at the light microscopy level. Some chromatin is heterochromatic in all tissues and at all stages of development; this is constitutive heterochromatin, and is detectable by C - banding. Some regions of chromatin can exist in either the heterochromatic or euchromatic state; these are known as facultative heterochromatin. Female mammals have two X chromosomes, one of which is largely inactive as far as transcription is concerned. It is converted into heterochromatin and can be observed as a small dense spot on the side of the interphase nucleus, known as a Barr body or X chromatin. ②Molecular Structure of Chromatin (chromosome): Chromatin(chromosome) is composed of DNA, proteins, and a small amount of RNA. The proteins are divided into two classes: histones and nonhistone, both of which play important roles in chromatin structure and function. Five types of histone are found, H_1, H_{2a}, H_{2b}, H_3, and H_4. This has been elucidated by the identification of nucleosomes, the basic building blocks of chromatin structure. Nucleosomes consist of a core of histones around which DNA is wound. Nucleosomes consist of core of histones around which DNA is wound. The core consists of two discs arranged in parallel each composed of four histone molecules, one each of H_{2a}, H_{2b}, H_3, and H_4. The DNA molecule runs along the rim of the discs, and a molecule of histone H_1 sits on the outside of the nucleosome complex acting as a seal; 146bp of DNA are associated with a nucleosome core. The length of the linker between nucleosomes varies between species but in humans it is about 60bp giving a total length of DNA per nucleosome of 200bp. This is the basic level of packing of DNA in chromatin. Further packing depends to a great extent on histone H_1. H_1 molecules can interact to hold the individual nucleosomes in a helical structure giving rise to a solenoid of 30nm diameter.

The Endomembrane System

We now focus on eukaryotic organelles that are formed of interrelated membranes . Some of these membranes are physically connected and some are not, but collectively they constitute a cytoplasmic network that biologists call the endomembrane system . Many of the organelles of this system work together in the synthesis, storage, and export of important molecules . These include the endoplasmic reticulum, Golgi bodies, and certain vesicles .

Endoplasmic Reticulum: The endoplasmic reticulum (ER) is the prime example of the direct interrelatedness of parts of the endomembrane system . (The term endoplasmic reticulum comes from Greek words meaning "network within the cell") .There are two kinds of ER: rough ER and smooth ER . These organelles differ in structure and function, but the membrances that form them are continuous . Membranes of the rough ER are also continuous with the outer membrance of the nuclear envelope . The space within the ER is separated from the cytoplasmic fluid by the ER membrane . Thus, the interconnected membrances of the ER and the nuclear envelope partition the inside of the cell into two separate compartments . Dividing the cell into compartments is a major function of the endomembrane system . .

The "rough" in rough endoplasmic reticulum refers to the appearance of this organelle in electron micrographs . The roughness results from ribosomes, which stud the membranes of the organelle . Rough ER is a network of interconnected flattened sacs, with two main functions . One is to make more membrane . Some of the proteins made by ER ribosomes are inserted into the ER membrane, as are phospholipids made by ER enzymes . As a result, the ER membrane enlarges, and some of it later ends up in other organelles . The other major function of rough ER is to make proteins that are secrected by the cell .

Smooth ER is free of ribosomes and curves through the cytoplasm like connecting pipe . One of the most important functions of ER is the synthesis of lipids, including fatty acids, phospholipids, and steroids . Each of these products is made by particular kinds of cells . In mammals, for example, smooth ER in cell of the ovaries and testes synthesizes the steroid sex hormones . Our liver cells also have large amounts of smooth ER, with additional kinds of functions . Certain enzymes in the smooth ER of liver help regulate the amount of sugar released from liver cells into the bloodstream . Other liver enzymes help break down drugs and other potentially harmful substances . Smooth ER has yet another function, the storage of calcium ions . In muscle tissue, these are necessary for contraction .

Golgi Apparatus: The electron microscope has revealed that a Golgi apparatus is a stack of flattened sacs formed of membranes, and the sacs are not interconnected like ER sacs . The number of Golgi stacks correlates with how active the cell is in secreting proteins .

The Golgi apparatus performs several functions in close partnership with the ER . Serving as a molecular warehouse and finishing factory, a Golgi apparatus receives and modifies substances manufactured by the ER . One side of a Golgi stack serves as a receiving dock for transport vesicles produced by ER . When a Golgi receives transport vesicles containing glycoprotein molecules, for instance, it takes in the materials and may then proceed to modify them chemically . Molecules move from sac to sac in the Golgi within transport vesicles . The "shipping" side of the Golgi stack serves as a depot from which finished secretory products, also packaged in transport vesicles, move to the plasma membrane for export from the cell . Alternatively, finished products may become part of the plasma membrane itself or of another organelle, such as lysosome .

Lysosomes: A fourth component of the endomembrance system is produced by the rough ER and the Golgi apparatus . The name lysosome is derived from two Greek words meaning "breakingdown body", and lysosomes consist of digestive (hydrolytic) enzymes enclosed in a membranous sac . First the rough ER puts the enzymes and membranes together, then a Golgi apparatus chemically refines the enzymes and releases mature lysosome . Lysosome illustrates the main theme of eukaryotic cell structure - compartmentalization . The lysosomal membrane encloses a compartment where digestive enzymes are stored and safely isolated from the rest of the cytoplasm . Without lysosomes, a cell could not contain active hydrolytic enzymes without digesting itself .

Lysosomes have several types of digestive functions . Many cells engulf nutrients into tiny cytoplasmic sacs called food vacuoles . Lysosomes fuse with the food vacuoles, exposing the nutrients to hydrolytic enzymes that digest them . Small molecular products of digestion, such as amino acids, leave the lysosome and are reused by cell . Lysosomes also help destroy harmful bacteria . Our white blood cells ingest bacteria into vacuoles, and lysosomal enzymes emptied into these vacuoles rupture the bacterial cell walls . Moreover, lysosomes serve as recycling centers for damaged organelles . Without harming the cell, a lysosome can engulf and digest parts of another organelle, making its molecules available for the construction of new organelles . Lysosomes also play vital roles in embryonic development . For example, lysosomal enzymes destroy cells of the webbing that joins the fingers of early human embryos .

Mitochondria

Energy that ATP molecules carry from one reaction site to another drives nearly all cell activities . In mitochondria (singular, mitochondrion), energy stored in breakingdown products of glucose and other organic compounds is used to form many ATP molecules . These organelles use oxygen to extract far more energy than can be done by any other means . When you breathe in, you are taking in oxygen primarily for mitochondria .

As with other organelles, the structure of the mitochondrion suits its function . Mitochondria is enclosed by two membranes . However, the mitochondria has only two compartments . The intermembrane space forms exone fluidfilled compartment . The inner membrane encloses the second compartment, containing a fluid the mitochondrial matrix . Many of the chemical reactions of cellular respiration occur in the matrix . The inner membrane is highly folded, and the enzyme molecules that actually make ATP are embedded in it . The folds, called aristae, greatly increase the membrane's surface area, enhancing the mitochondria's ability to produce ATP.

Ribosome

Polypeptide chains are assembled as a result of codon anticodon interactions. And those interactions take place at specific binding sites on the surface of ribosomes. A ribosome has two subunits, each composed of rRNA and a number of proteins. The two subunits perform their functions only during translation. Transfer RNA molecules deliver amino acids to two binding sites, called the P and A sites, which are very close together on the smaller of the two ribosomal subunits. That same subunit also has a binding site for mRNA. Ten thousand ribosomes may be present in the cytoplasm of a single bacterial cell. A eukaryotic cell may contain many tens of thousands. The bacterial ribosome is only 25 nanometers wide. That's about a millionth of an inch. Although the components of a eukaryotic ribosome are larger and more numerous, both kinds of ribosomes have nearly the same shape and function.

The Cytoskeleton

Many of the organelles we have already described provide some structural support for cells. In addition, eukaryotic cells contain a supportive meshwork of fine fibers, collectively called the cytoskeleton. Three main kinds of fibers make up the cytoskeleton: microfilaments, the thinnest type of fiber; microtubules, the thickest; and intermediate filaments, between in thickness.

Microfilament: Microfilaments are solid helical rods composed mainly of a globular protein called actin. Each microfilament consists of a twisted double chain of actin molecules. Actin microfilaments can help cells change shape and move by assembling(adding subunits) at one end while disassembling (losing subuning) at the other. The amoeboid(crawling) movement of the protist Amoeba and certain of our white blood cells involves this sort of process. In addition, actin microfilaments often interact with other kinds of protein filaments to make cells contract. This function of microfilaments is best known from studies of muscle cells.

Intermediate Filament: Intermediate filaments are a varied group. They are made up of fibrous proteins rather than globular ones and have a ropelike structure. Intermediate filaments serve mainly as reinforcing rods for bearing tension but also help anchor certain organelles. For instance, the nucleus is often held in place by a cage of intermediate filaments.

Microtuble: Microtubles are straight, hollow tubes composed of globular proteins called tubulins. Microtubules elongate by adding subunits consisting of tubulin pair. They are readily disassembled in a reverse manner, and the tubulin subunits can then be reused in another microtuble. Microtubles that provide rigidity and shape in one area may disassemble and then reassemble elsewhere in the cell. Other important functions of microtubles are to provide anchorage for organelles and to act as tracks along which organelles can move within the cytoplasm. For example, a lysosome might move along a microtubule to reach a food vacuole . Microtubles also guide the movement of chromosomes when cells divide, and, as we see next, they are the basis of ciliary and flagellar movement .

Centrioles

Centrioles are small cylindrical bodies, barely visible under a light microscope, that lie just outside the nucleus in an area of specialized cytoplasm . They are normally found in the cells of animals, algae, and some fungi; They are absent in the cells flowering plants .

Centrioles have a characteristic structure of nine sets of microtubles running lengthwise just below their surface . Usually centrioles are paired, each lying at right angles to the other, forming a kind of" T ".

They are associated with structures that function in organizing microtubules that serve in cell division and cell motility . For example, in some cells centrioles may play a role in organizing the microtubules of spindle fibers that serve to separate the copies of genetic information(chromosome)during cell division . However, cells that lack centrioles, those of flowering plants for instance, are still able to form spindle fibers . The role of centrioles in cell movement is to give rise to basal bodies, short cylinders of microtubules that are arranged in the same manner as those in the centrioles . In turn the basal bodies direct the formation of cilia and flagella .

Cilia and Flagella

Cilia and flagella are hairlike extensions that project from the surfaces of certain kinds of cells . They differ only in length; cilia are about 10 to 30 micrometers, whereas flagella may extend to thousands of micrometers . Both make" beating " movements, and both may function in moving the cell along through some fluid . Cilia, in addition, move substances across the surface of a stationary cell . As an example, a sperm cell swims by beating its whiplike flagellum, and the beating cilia that line your breathing passages help sweep away airborne debris(unless you have killed them by smoking) . Both cilia and flagella contain microtubules that form a 9 + 2 arrangement . Basically, the structure involves a circle of nine pairs of microtubules surrounding two single microtubules . (The arrangement in centrioles is similar, but they lack the central pair) . The 9 + 2 arrangement of cilia and flagella has generated much speculation about their origin . For example, the basal body may act as a template that organizes the microtubules within a cilium or flagelleum .

Membrane Structure and Functions

Membranes order metabolism . They are selectively permeable, controlling the flow of substances into and out of a cell and among compartments within a cell . They can also hold teams of enzymes that function in metabolism .

The Lipid Bilayer: Lipids, mainly phospholipids, are the main structural components of membranes . A phospholipids consists of a hydrophilic(water - loving) head and two fatty acid tails that are mainly hydrophobic(water dreading) . The structure of phospholipid molecules is well suited to their role in membranes . In water, phospholipids spontaneously form a stable two - layer framework called a phospholipid bilayer . Their hydrophilic heads face outward, exposed to the water, and their hydrophobic tails point inward, shielded from the water . This is the arrangement that membrane phospholipids have in the watery environment within living organisms . The hydrophobic interior of the bilayer is one reason membranes are selectively permeable . Nonpolar, hydrophobic molecules are soluble in lipids and can easily pass through membranes . In contrast, polar, hydrophilic molecules are not soluble in lipids . Whether polar molecules pass through the membrane depends on protein molecules in the phospholipid bilayer . In fact, much of a membrane's selective permeability depends on membrane proteins, which we examine in the next module .

The Fluid Mosaic Model of Membrane Structure: In electron microscope, you can see that the plasma membrane has three zones: an outermost dark band, a light zone just inside it, and a second dark band bordering the outer edge of the cytoplasm . A generalized plasma membrane may best be summarized in what is called the fluid mosaic model . The currently accepted model of a plasma membrane in which" mosaics "of proteins are imbedded in a bilayer of phospholipids . The membrane mosaic is fluid in that most of the individual proteins and phospholipid molecules can drift laterally in the membrane . Helping to hold the delicate membrane in place, some of the proteins are linked both to the cytoskeleton and to fibers of the extracellular around the cell . Resulting from double bonds in lipid tails, the kinks make the membrane more fluid by keeping adjacent phospholipids from packing tightly together . The steroid cholesterol, wedged into the bilayer, helps stabilize the phospholipids at body temperature but helps keep the membrane fluid at lower temperatures . In a living cell, the phospholipid bilayer remains about as fluid as salad oil at room temperature . The two surfaces of any membrane are different . For the plasma membrane, the outside has carbohydrates covalently bonded to proteins and lipid in the membrane . The carbohydrate portions of glycoproteins and glycolipids vary from species to species, from one individual to another in the same species, and from one cell type to another in a single individual .

Functions of Membrane Proteins: The word" mosaic" as applied to a membrane refers not only to the positioning of proteins in the phospholipid bilayer but also to the varied activities of these proteins . In fact, proteins perform most of the functions of the membrane . More than 50 different kinds of proteins have been found in the plasma membrane of human red blood cells, and there are probably many more that are just too scarce to have been detected so far . We have already mentioned several functions of membrane proteins, including attaching the membrane to the cytoskeleton and external fibers, providing identification tags, and forming junctions between adjacent cells . Other proteins function as receptors for chemical messengers from other cells . Finally, some membrane proteins help move substances across the membrane through small molecules such as O_2 pass freely through the phospholipid bilayer, many essential molecules need assistance from proteins to enter or leave the cell .

Movement of Substances into and out of Cells: ①Diffusion: Because a cell does not perfom work when molecules diffusion across its membrane, the diffusion of a substance across a biological membrane is called passive transport . Passive transport is extremely important to all cells . It is a key factor in the exchange of substances between cell and tissue fluids . In our lungs, for example, passive transport along concentration gradients is the sole means by which oxygen(O_2, essential for metabolism) enters red blood cells and carbon dioxide(CO_2, a metabolic wastes) passes out of them . Water is another substance that crosses membranes by passive transport . ② Osmosis: Diffusion of water molecules across a selectively permeable membrane is a special case of passive transport called osmosis . If a membrane permeable to water but not to solutes separates two solutions with different concentrations of solutes(here a molecule such as glucose), water crosses the membrane until the solute concentrations are equal on both sides . The direction of osmosis is determined only by the difference in total solute concentration, not by the nature of the solutes . Only if the total solute concentrations are the same on both sides of the membrane will water molecules move at the same rate in both directions . Solution of equal solute concentration is said to be isotonic . ③ Facilitated Diffusion: A membrane protein with passive transport functions is highly selective about which solutes it will assist across the membrane . A protein that transports glucose, for instance, will not transport amino acids . And the protein only helps a particular solute move in the direction that simple diffusion would take it(down its concentration gradient) . That is why this transport mechanism is called facilitated diffusion . When water - soluble molecules bind with the groups, the binding seems to trigger a change in the protein shape . This change permits the solute to move through the hydrophilic interior . While the solute makes its passage, the protein closes in behind it and returns to its original shape . ④ Active Transport: In contrast to passive transport, active transport requires that a cell expend energy to move molecules across a membrane . In this situation, a transport protein actively pumps a specific solute across a membrane against the solute's concentration gradient, that is, away from the side where it is less concentrated . Membrane proteins usually use ATP as their energy source for active transport . An active transport system involves the passage of two different solutes across a membrane in opposite direction . The transport protein has a separate binding site for each of the solutes . ⑤ Exocytosis and Endocytosis: A cell uses the process of exocytosis to export bulky materials from its cytoplasma . In the first step of this process, a membrane - enclosed vesicle filled with macromolecules move to the plasma membrane . Once there, the vesicle fuses with the plasma membrane, and the vesicle's contents spill out of the cell . In another example, certain cells in the pancreas manufacture the hormone insulin and secrete it into the bloodstream by exocytosis . In endocytosis, part of the plasma membrane sinks inward and balloons around particles, fluid, or tiny prey . It seals on itself to form a vesicle, which transports its contents or stores them in the cytoplasma . Free - living phagocytic cells, including amoebas, trap bacterial cells and other foreign items by extending pseudopods around them . The lobes of cytoplasma wrap around the trapped item and