生物专业英语

Biology English

李关荣　王贵学　主　编

西南师范大学出版社

图书在版编目(CIP)数据

生物专业英语/李关荣,王贵学主编.—重庆:西南师范大学出版社,2007.9
ISBN 978-7-5621-3878-5
Ⅰ.生… Ⅱ.李… Ⅲ.生物学—英语—高等学校—教材
Ⅳ.H31

中国版本图书馆CIP数据核字(2007)第076761号

生物专业英语

李关荣　王贵学　主编

责任编辑:李　玲　杜珍辉
出版发行:西南师范大学出版社
地址:重庆市北碚区天生路1号
邮编:400715　市场营销部电话:023—68868624
http://www.xscbs.com
经　　销:全国新华书店
印　　刷:西南农业大学印刷厂
开　　本:787mm×1092mm　1/16
印　　张:10.5
字　　数:248千字
版　　次:2007年9月　第1版
印　　次:2007年9月　第1次印刷
书　　号:ISBN　978-7-5621-3878-5

定　　价:17.00元

前　言

《生物专业英语》是全国许多高等院校生物技术、生物科学、生物工程及相关专业的必选课之一。它是在学生具有一定的相关生物学基础知识上，通过学习相关的反映这些普通生物学和现代生物学的基础知识的英文短文，掌握生物学基本知识及其英文表述方法和特点，了解现代生命科学的发展方向和研究前沿，进而提高对英文科技文章的阅读和理解、专业英语表达以及英文科技论文的写作能力。

本书注重现代生物学发展趋势，兼顾继承和发展，正确处理了经典生物学和现代生物学知识及生物学问题的关系，理论联系实际。并考虑教学特点，拓宽学生的生物学基础知识面，兼顾生物学一级学科的主要分支，重点突出，脉络清晰。

本书是作者根据多年的专业英语教学经验和积累的大量相关资料，经系统整理、修订而完成的。为保持专业英语的地道性和时代特点，内容来源于如美国的《时代周刊》、*Lehninger Principles of Biochemistry*（David L. Nelson and Michael M. Cox Eds，2000，the 3rd edition）以及国内外许多相关学习网站等多种媒体，经系统整理改编，主要用于教学目的。编者对相关人员和单位表示衷心的感谢。主要内容有动物、植物、微生物及人体的结构、生理、生化及遗传等方面的基础知识；分子生物学、遗传工程、克隆技术、转基因学与食品安全、基因组学、蛋白组学和生物信息学等现代生物学知识前沿及动态。本书基本覆盖了生物学一级学科的主要分支，可供生物技术、生物科学、生物工程、农学等相关专业的学生和教师使用。

全书共分 13 个单元:科技英语的概念及写作特点,细胞结构和原生质的特性,生物化学,植物学及植物生理,遗传与进化,人类解剖及生理,微生物,动物行为,食品、营养与健康,分子生物学及转基因学,生物技术,基因组学和蛋白组学、生物信息学基础。每单元选择代表性短文 1～7 篇以上,共 50 篇短文。短文中的专业词汇及疑难句子结构都编了号,便于在随后的"Notes"部分查阅。专业词汇都给出了国际音标注音和主要中文释义。

由于编者水平有限,现代生命科学发展迅猛,书中难免有疏漏和不妥之处,望读者多提意见,以便再版时修订。

目录

UNIT 01 THE CONCEPT AND CHARACTERISTICS OF SCIENTIFIC ENGLISH

Essay 01 The Concept of English for Science and Technology

1. English is a global language. With the rise and rapid spreading of electronic communication, worldwide trade and international travel, its status has far surpassed that of a link language. To some extent, English is equated with success. Wherever you go, from the luxuriant rain forests of Costa Rica[1] to the untamed wilds of Serengeti[2] to the hodgepodge[3] of Eastern bazaars[4], you're sure to find someone who speaks English albeit[5] in an accent far different from yours. If nothing else, English makes a disguised appearance in hybrids such as Franglais[6], Spanglish[7], Hindlish[8], Chinglish[9], *etc*.
2. Nowadays English is established not just as the *linqua franka*[10] of the world but also as the international language of science and technology. An increasing number of scientists and technicians across the world are obliged to read an increasing proportion of research papers and textbooks written in scientific English. Over the last decades or so the term EST, English for Science and Technology, has appeared frequently in English teaching-related literature.
3. The language of EST that expresses scientific and technical concepts, theories and facts is not a different language from that of the daily conversation or literature. But, due to its role in science and technology, EST covers a special range of English. English language learners require English so as to promote their educational specialty or to perform efficiently their roles as scientists, technologists, technicians, *etc*. A general English can hardly meet such needs as these. Consequently, English for Special Purposes (ESP)[11] has emerged as a branch of English language study.
4. ESP consists of EAP[12] (English for Academic Purposes), EOP[13] (English for Occupational or Vocational Purposes) and EST[14] (English for Science and Technology). EAP is used by overseas students, researchers and visiting scholars at schools and universities in Britain and America or in any other countries where English is used in courses and lectures; In the United States EOP (English for Occupational or Vocational Purposes) is also called "English for Careers". It is the English necessary for some occupational requirements, *e. g.* for international telephone operators, international air traffic controllers, international commerce, international railways, computer programming, tourism and so on, or vocational training programs, *e. g.* for hotel and catering staff, technical trades, *etc*.

5. Our era is the age of machines, electronic computers and ever-advancing biology. Only by obtaining a solid knowledge of science, can one function normally and successfully in modern society. With the development of science and technology, especially biology-related disciplines, scientists and engineers strive to exchange their ideas, discoveries and inventions, collect information and data, interpret concepts and theories, comment on the latest scientific advances and write reports based on experimental procedures, *etc*. More and more scientific terms from modern biology such as, clone[15], GM[16] (Genetically modified) foods, gene, genomics[17], proteomics[18], transgenics[19], DNA chips[20], *etc*., are becoming popularized. The need increases day by day for scientists and engineers to have a swift, economical, efficient, impersonal and sometimes international means of communication.
6. However, EST is not the popularized accounts of the technical subjects as are found in encyclopedias[21] or books intended for general readers. It has its own authentic[22] language of science! Lately, textbooks have been appearing that attempt to reflect the nature of the language actually used by scientists and the function it serves. However some people still ignore the existence of EST all together, while others are quite indifferent to it. They draw a simple formula like this: EST= General English Grammar + Technical Words. They thought that they would be able to understand EST by simply knowing grammatical rules in addition to some technical words.
7. Unfortunately, this judgment gives no fruitful comprehension about the nature of EST. They do not seem to be aware that EST presents linguistic varieties with its own characteristic features.
8. Since scientists try to be impersonal in narrating the natural phenomena and facts, their processes, properties and characteristics, English for Science and Technology (EST) must be evidently precise, concise, clear and restricted and includes many mathematical equations, formulae, diagrams, tables, *etc*. Biology related publications are more so ever. Scientists also prefer some typical sentence patterns and a large number of technical and semi-technical terms, which make English for Science and Technology different to a very wide extent from ordinary English.

Notes

[1] Costa Rica [5kRstE5ri:kE] *n*. **哥斯达黎加**

[2] Serengeti [siren`giti] *n*. **塞伦盖提**

[3] hodgepodge [5hRdVpCdV] *n*. **大杂烩**

[4] bazaar[bE5zB:] *n*. **集市,闹市**

[5] albeit[C:l5bi:it] *adv*. **虽然**

[6] Franglais [frB:n5glei] *n*. **(法语中的)英语外来语**

[7] Spanglish [5spAnliF] *n*. **混有西班牙文英语**

[8] Hindlish [hindliF] *n*. **混有印度语的英语**

[9] Chinglish [tFin^liF] *n*. **混有中文的英语**

[10] *linqua franka* [5liN^w[5frANk[] *n*.

通用语,混合语

[11] ESP:English for Special Purposes 特殊用途英语

[12] EAP:English for Academic [7AkE5demik] Purposes 学术用途英语

[13] EOP: English for Occupational [7Rkju5peiF[n[l] or Vocational [vEu5keiF[n[l] Purposes 职业英语

[14] EST: English for Science and Technology 科技英语

[15] clone [kl[un] *n.* 克隆

[16] GM (Genetically modified) food 遗传修饰食品

[17] genomics [`dVi:n[Umiks] *n.* 基因组学

[18] proteomics [`pr[uti[umiks] *n.* 蛋白组学

[19] transgenics [trAns5dVeniks] *n.* 转基因学

[20] DNA chip [tFip] DNA 芯片

[21] encyclopedia [en7sBikl[u5pi:di[] *n.* 百科全书

[22] authentic [R:5Wentik] *adj.* 真实可信的

Essay 02 Must We Write?

1. Many new findings and discoveries are documented with references to the scientific literature, indicated by the names of the author(s) and the year of publication. Publication, as it turns out, is an absolutely essential part of the scientific progress, as Page Morgan explains in this essay. Dr. Morgan is a Professor of Plant Physiology in the Department of Soil and Crop Science at Texas A&M University. For many years, he has also been an Associate Editor (for plant development and growth regulators) of the journal Plant Physiology. Prof. Morgan tells us how the system works and gives a few pointers to manuscript preparation for the scientific literature.
2. Scientists must write! Knowledge un-communicated is effectively unknown; discovery is but one step on the path of understanding. Although you may agree with these statements, you may not be aware how often scientists and science students[1] are poorly prepared to write. Are genes for writers' block[2] linked to those for investigative talent? Probably not, but while a student is studying the concepts of science, practicing its techniques, and learning its literature, it may be difficult to find the time to develop good communications skills. These skills take practice to develop. Educators soon learn that many students hate to write. Given my experience in teaching, advising graduate students, and serving as a decision editor[3] for a scientific journal, I would like to discuss writing with the readers of this text.
3. The first point is that writing is necessary. As a young faculty[4] member I remember hearing our Dean[5] say, "Research is not completed until it is published." He was right. Students must ultimately write what they have discovered or learned. Quizzes, reports, term papers, theses, and dissertations[6] allow others to know and judge your

ability and accomplishments. Students who follow a scientific career soon are involved in written communications: justifications[7] for equipment purchases, course outlines, research funding proposals, and manuscripts reporting research findings. Review articles[8], books and pieces for the semi-popular[9] press, flow from the pens (or computer keyboards) of the more prolific[10]. Writing is essential in science!

4. This discussion is not to advocates "Publish or Perish[11]", but rather "Publish or No One Will Know." Until you mentally wrestle with[12] a question and write down your best answer, your instructor cannot evaluate how well you have learned. Likewise, until scientists have published the results and conclusions from their experiments, no one else can evaluate[13] the significance and usefulness of the work. Only after new facts and ideas are published, discussed, and replicated[14] by further testing can the valid ones ultimately contribute to advancing understanding in science as a whole.

5. Unfortunately, it's not enough to write; the need is to write well. Consider two students who spend hours in the library researching the same term-paper topic. Equally well versed[15] in the facts, one writes an uninspired[16], catalog-like listing of who did what and when. The second student identifies the relevant questions, arrays the facts to support logical deductions[17], and brings the topic to a sharply focused conclusion. One wrote and the other wrote well. At the professional level the objective for writing a scientific paper is not to get it published, but rather to communicate with other scientists. Everyone has a limited amount of time. Writers are literally[18] competing for the time and attention of potential readers. Regardless of how important a discovery is, it will usually be more rapidly accepted if it is presented in a well-written paper. On the other hand, if the writing is poor and the message obscure, readers will often quit before completing the paper.

6. Perhaps some "do's" and "don'ts" would be helpful. Most instructors have seen a lot of bad writing; thus, the "don'ts" are easy to list. In my experience, the most common error is that writers fail to clearly state their message. The reader wonders: what do we learn about plant physiology from the experiment? Is it new or unique? Is it useful? The student writing a lab report[19] or the scientist writing for a journal has the responsibility to answer those questions. Another common error occurs when a manuscript appears to be a partially condensed thesis. The message is lost in wordiness[20] and secondary topics, and a 10-page story gets told in 25. Also, the technical language of experimental design and statistics is often used as a writing crutch[21]; As a result, clarity[22] suffers. Readers are usually interested in what the response was, and its magnitude, variability, and reproducibility. Jargon[23] about "significant three-way interactions in complete factorials" prompts drowsiness.

7. Another common writing error is careless preparation. Most writing tasks, whether something as simple as an essay examination or as complicated as reviewed journal manuscript, including instructions. Yet time after time writers appear to ignore the instructions and submit carelessly prepared material. The axiom[24] "You never get a second

chance to make a good first impression" certainly applies to writing. Although technical aspects of composition are beyond the scope of this essay, students would be well served to develop the habit of reviewing their writing for spelling, punctuation, and sentence structure before it is submitted to others. Writing handbooks list the common mistakes, such as using which in place of that. Equip yourself with a good writing handbook and a dictionary, and use them!

8. The positive suggestions for scientific writing must start with the scientific method. There is no substitute for expressing the topic as a question that can be answered. Searching out what is already known is equally indispensable[25]. If a writer sits down to write, for example, about some topic as broad as "tissue-culture studies with soybeans," or if a writer dismisses relevant background knowledge with words such as "little is known about this subject", the paper may already be unsalvageable. Writers should have the primary message of their papers in mind before they write the first word. That message, in fact, should be an answer to a clearly stated question, and it should shape the title, the introduction, and the body of the paper. In that way readers can recognize a theme[26] that is consistent throughout the paper.
9. The purpose of scientific writing is to communicate findings, analyses, conclusions, and theories. Communicate is the operative[27] word. Unless the reader understands, the writer has failed. The implications[28] are obvious: Identify the audience and write to that level of understanding. Clarity is often inversely related to sentence length. A barrage[29] of words with obscure meanings makes reading a chore[30] rather than a pleasure. The words selected should aid communication rather than make a statement about the writer's vocabulary. Sentences that can be misunderstood usually will be. Brevity[31] is a virtue when wed to clarity. Writers should write in a direct, simple, logical style; the reward is being read and being understood.
10. Writers should give serious attention to graphic illustration. Poor ones frequently appear to be an afterthought[32]. Excellent illustrations of findings or conclusions are often the most effective way to communicate. The saying that "One picture is worth a thousand words" makes that point. Good illustrations don't just happen; they take the forethought[33], inventiveness and work. We train graduate students to give seminars with much emphasis on good slides. That emphasis is intended to carry over into their written communications. Computer graphics make the job easier, but the bottom line is still personal initiative[34].
11. In conclusion, the ability to write well is a skill needed by science students and scientists alike. It can be acquired and cultivated if the basic goal of communication is kept clearly in view. Those who can think and speak logically can learn to write logically, and even interestingly and entertainingly. Science will be the better for such writing!

Notes

[1] science student *n.* 理科学生
[2] block *n.* (俚语)脑袋
[3] decision editor [di5siV[n 5edit[] 决策编辑
[4] faculty [5fAk[lti] *n.* 全体教员
[5] Dean [di:n] *n.* 大学院长,系主任
[6] dissertation [9dis[5teiF[n] *n.* (学位)论文,专题,论述,学术演讲
[7] justification [dVQstifi5keiF[n] *n.* 认为有理,认为正当,理由,辩护,释罪
[8] review article *n.* 综述文章
[9] semi-popular *adj.* 半科普的
[10] prolific [pr[5lifik] *adj.* 多产的,丰富的,大量繁殖的
[11] perish [`periF] *vi.* 毁灭,死亡,腐烂,枯萎 *vt.* 毁坏,使麻木
[12] wrestle [5resl] with *vi.* 与……搏斗
[13] evaluate [i5vAljueit] *vt.* 评价,估计,求……的值 *v.* 评价
[14] replicate [`replikit] *v.* 复制
[15] versed [v[:st] *adj.* 熟练的,精通的
[16] uninspired [`Qnin5spai[d] *adj.* 未赋予灵感的,缺乏创见的,平凡的
[17] deduction [di`dQkF[n] *n.* 缩小,减小,扣除,折扣,扣除额,折扣额,推论,演绎法
[18] literally [`lit[r[li] *adv.* 照字面意义,逐字地
[19] lab report 实验报告
[20] wordiness [`w[:dines] *n.* 多嘴,冗长
[21] crutch [krQtF] *n.* (跛子用的)拐杖,支撑,帮助
[22] clarity [5lAriti] *n.* 清楚,透明
[23] jargon [`dVB:g[n] *n.* 行话
[24] axiom [`Aksi[m] *n.* 公理,自明之理:不言而喻的或普遍被认定的真理;格言
[25] indispensable [9indis5pens[bl] *adj.* 不可缺少的,绝对必要的
[26] theme [Wi:m] *n.* (谈话,写作等的)题目,主题
[27] operative [`Rp[r[tiv] *adj.* 有效的;有力量的;行动的,实用的
[28] implication [9impli`keiFEn] *n.* 牵连,纠缠,含蓄,含意,暗示
[29] barrage[`bArB:V] *n.* 拦河坝,堰,阻塞,(敌军前进的)弹幕射击
[30] chore [tFR:] *n.* 家务琐事
[31] brevity [5breviti] *n.* (时间)短暂,(讲话,文章等)简短
[32] afterthought [`B:ft[WR:t] *n.* 事后产生的想法,追悔,再思
[33] forethought [`fR:WC:t] *n.* 深谋远虑,先见
[34] initiative [i`niF[tiv] *n.* 主动性

UNIT 02 FEATURES OF CELLS AND PROTOPLASM

Essay 03 An Introduction to Cells

1. Cells are the structural and functional units of all living organisms. The smallest organisms consist of single cells and are microscopic, whereas larger organisms are multicellular[1]. The human body, for example, contains at least 10^{14} cells. Unicellular[2] organisms are found in great varieties throughout virtually every environment from Antarctica to hot springs to the inner recesses[3] of larger organisms. Multicellular organisms contain many different types of cells, which vary in size, shape, and specialized function. Yet no matter how large and complex the organism, each of its cells retains some individuality and independence.
2. Despite their many differences, cells of all kinds share certain structural features. The plasma membrane[4] defines the periphery[5] of the cell, separating its contents from the surroundings. It is composed of enormous numbers of lipid and protein molecules, held together primarily by noncovalent hydrophobic interactions[6], forming a thin, tough, pliable, hydrophobic layer around the cell. The membrane is a barrier to the free passage of inorganic ions and most other charged or polar compounds. Transport proteins[7] in the plasma membrane allow the passage of certain ions and molecules. Other membrane proteins include receptors[8] that transmit signals from the outside to the inside of the cell and enzymes[9] that participate in membrane-associated reaction pathways.
3. Because the individual lipids and proteins of the plasma membrane are not covalently linked, the entire structure is remarkably flexible, allowing changes in the shape and size of the cell. As a cell grows, newly made lipid and protein molecules are inserted into its plasma membrane; cell division[10] produces two cells, each with its own membrane. Growth and fission occur without loss of membrane integrity[11]. In a reversal of the fission process, two separate membrane surfaces can fuse, also without loss of integrity. Membrane fusion and fission are central to mechanisms of transport into and out of the cells known as endocytosis[12] and exocytosis[13], respectively.
4. The internal volume bounded by the plasma membrane, the cytoplasm[14], is composed of an aqueous solution, the cytosol[15], and a variety of insoluble, suspended particles. The cytosol is a highly concentrated aqueous solution with a complex composition and gel-like consistency. Dissolved in the cytosol are many enzymes and the RNA molecules

that encode[16] them, the monomeric subunits[17] (amino acids[18] and nucleotides[19]) from which these macromolecules[20] are assembled, hundreds of small organic molecules called metabolites[21], intermediates in biosynthetic and degradative pathways, enzymes[22] that are essential participants in many enzyme-catalyzed reactions, and inorganic ions.

5. Among the particles suspended in the cytosol are supramolecular complexes[23] and, in almost all nonbacterial cells, a variety of membrane-bounded organelles[24] containing specialized metabolic machinery. Ribosomes[25], small particles 18 to 22 nm in diameter, that are composed of over 50 different protein and RNA molecules, are the sites at which protein synthesis occurs. Ribosomes engaged in protein synthesis often occur in clusters called polysomes (polyribosomes)[26] held together by a strand of messenger RNA. Also present in the cytoplasm of many cells are granules or droplets containing stored nutrients such as starch and fat.
6. All living cells have, for at least some part of their life, either a nucleus[27] or a nucleoid[28], in which the genome[29] (the complete set of genes composed of DNA) is stored and replicated. The DNA molecules are always far longer than the cells themselves and are tightly folded and packed within the nucleus or nucleoid as supramolecular complexes of DNA with specific proteins. The bacterial nucleiod is not separated from the cytoplasm by a membrane, but in higher organisms the nuclear material is enclosed within a double membrane, the nuclear envelope[30]. Cells with nuclear envelopes are called eukaryotes[31] (Greek eu, "true", and Karyon, nucleus); those without nuclear envelops-bacterial cells-are prokaryotes[32] (Greek pro, 'before').
7. Unlike bacteria, eukaryotes have a variety of other membrane-bounded organelles in their cytoplasm, including mitochondria[33], endoplasmic reticulum[34], Golgi complexes[35], lysosomes[36] and vacuoles[37] (related organelles found in animal and plant cells, respectively), and, in photosynthetic cells, chloroplasts[38].

Notes

[1] multicellular [7mQlti`seljul[] adj. **多细胞的**

[2] unicellular [`ju:ni`seljul[] *adj*. **单细胞的**

[3] recess [ri`ses] *n*. **(墙壁等的)凹进处,[解]隐窝**

[4] plasma membrane [`plAzm[ `membrein] *n*. **质膜**

[5] periphery [p[`rif[ri] *n*. **外围**

[6] noncovalent hydrophobic interaction [7nQnkEU`veil[nt 7hBidr[J`f[Jbik 9int[r`AkF[n] **非共价键疏水相互作用**

[7] transport protein *n*. **转运蛋白**

[8] receptors *n*. **受体**

[9] enzyme [`enzaim] *n*. **酶**

[10] cell division *n*. **细胞分裂**

[11] membrane integrity [`membrein in`tegriti] *n*. **膜的完整性**

[12] endocytosis [9end[usBi`t[usis] *n*. **(细胞)内吞作用**

[13] exocytosis [9eks[usai`t[usis] n. 胞外分泌
[14] cytoplasm [`sait[uplAzm] n. (细)胞质
[15] cytosol [`sait[usCl] n. (细)胞浆
[16] encode [in5k[ud] vt. 编码
[17] monomeric subunit [7mRn[`merik sQb5jU:nit] n. 单体亚单位
[18] amino acid [5Amin[U `Asid] 氨基酸
[19] nucleotide [`njU:kli[taid] n. 核苷酸
[20] macromolecule [9mAkr[U`mRlikju:l] n. 大分子，高分子
[21] metabolite [mi`tAb[lait] n. 代谢物
[22] coenzyme [k[U`enzaim]] n. 辅酶
[23] supramolecular complex [9sjU:pr[m[`lekjul[ `kRmpleks] 超分子复合物
[24] organelle [9C:g[`nel] n. 细胞器
[25] ribosome [`raib[s[um] n. 核糖体
[26] polysome [`pRlis[um] (polyribosome) [9pRli`raib[s[um] n. 多核糖体
[27] nucleus [`njU:kli[s] n. 细胞核，核
[28] nucleoid [`njU:kliRid] n. 类核
[29] genome [`dVi:n[Um] n. 基因组
[30] nuclear envelope [`njU:kli[ `envil[Up] n. 核膜
[31] eukaryote [ju`kAri[ut] n. 真核细胞
[32] prokaryote [pr[U`kAri[ut] n. 原核细胞
[33] mitochondrion [9mait[`kRndri[n] n. 线粒体(sing.) mitochondria [9mait[`kRndri[]线粒体(pl)
[34] endoplasmic reticulum [`end[u9plAzmik ri`tikjul[m] n. 内质网
[35] Golgi complex [`gC:ldVi `kRmpleks] n. 高尔基复合体
[36] lysosome [`lais[s[Um] n. 溶酶体
[37] vacuole [`vAkju[ul] n. 液泡
[38] chloroplast [`klCr[plB:st] n. 叶绿体

Essay 04 Major Structural Features of Eukaryotic Cells

1. Typical eukaryotic cells are much larger than prokaryotic cells — commonly 5 to 100μm in diameter, with cell volumes a thousand to a million times larger than those of bacteria. The distinguishing characteristic of eukaryotes is the nucleus, which has a complex internal structure surrounded by a double membrane. Another striking difference between eukaryotes and prokaryotes is that eukaryotes contain a number of other membrane-bounded organelles. The following describe the structures and roles of the components of eukaryotic cells in more detail.

The Plasma Membrane Contains Transporters and Receptors

2. The external surface of a cell is in contact with other cells, the extracellular[1] fluid, and the solutes, nutrient molecules, hormones[2], neurotransmitters[3], and antigens[4] in that fluid. The plasma membranes of all cells contain many transporters, proteins that span the membrane and carry nutrients into the cell and various products out. Cells also have surface membrane proteins (signal receptors[5]) with highly specific binding sites for extracellular signaling molecules (receptor ligands[6]). When an external ligand binds to its specific receptor, the receptor protein transduces the signal carried by that

ligand into an intracellular[7] message. For example, some surface receptors are associated with ion channels[8] that open when the receptor is occupied, permitting entry of specific ions; others activate or inhibit cellular enzymes on the inner membrane surface. Whatever the mode of signal transduction, surface receptors characteristically act as signal amplifiers—a single ligand molecule bound to a single receptor may cause the flux of thousands of ions thru an opened channel or the synthesis of thousands of molecules of an intracellular messenger molecule by an activated enzyme.

3. Some surface receptors recognize ligands of low molecular weight, and others recognize macromolecules. For Example, binding of acetylcholine[9] (Mr=146) to its receptor begins a cascade[10] of cellular events that underlie the transmission of signals for muscle contraction. Blood proteins (Mr>20,000) that carry lipids (lipoproteins[11]) are recognizes by specific cell surface receptors, which mediate lipid entry into the cells. Antigens (proteins, viruses, or bacteria, recognized by the immune system as foreign) bind to specific receptors and trigger the production of antibodies[12]. During the development of multicellular organisms, neighboring cells influence each other's developmental paths, as signal molecules from one cell type react with receptors of other cells. Thus the surface membrane of a cell is a complex mosaic[13] of different kinds of highly specific "molecular antennae"[14] thru which cells receive, amplify, and react to external signals.

4. Most cells of higher plants have a cell wall outside the plasma membrane, which serve as a rigid, protective shell. The cell wall, composed of cellulose[15] and other carbohydrate polymers, is thick but porous. It allows water and small molecules to pass readily, but swelling of the cell due to the accumulation of water is resisted by the rigidity of the wall.

Endocytosis and Exocytosis Carry Traffic across the Plasma Membrane

5. Endocytosis is a mechanism for transporting components of the surrounding medium deep into the cytoplasm. In this process, a region of the plasma membrane invaginates[16], enclosing a small volume of extracellular fluid within a bud that pinches off inside the cell by membrane fission. The resulting small vesicle[17] (endosome[18]) can move into interior of the cell, delivering its contents to another organelle bounded by a single membrane (a lysosome, for example) by fusion of the membranes. The endosome thus serves as an intracellular extension of the plasma membrane, effectively allowing intimate contact between components of the extracellular medium and regions deep within the cytoplasm, which could not be reached by diffusion alone. Phagocytosis[19] is a special case of endocytosis in which the material carried into the cell (within a phagosome[20]) is particulate[21], such as a cell fragment or even another, smaller cell. The inverse of endocytosis is exocytosis, in which a vesicle in the cytoplasm moves to the inside surface of the plasma membrane. Many proteins destined for secretion into the extracellular space are packaged into vesicles called secretory granules then released by ex-