



# 世界最新

# 英汉双解生物技术与遗传工程词典

主 编 Mark L.Steinberg  
Sharon D.Cosloy

主 译 宋土生

主 审 陈苏民

The Facts On File  
**Dictionary of Biotechnology and  
Genetic Engineering**

世界图书出版公司

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英汉双解生物技术与遗传工程词典

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## Dictionary of Biotechnology and Genetic Engineering

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# 序

本词典为系列词典之一。其余的词典分别为:《生物学词典》、《细胞与分子生物学词典》、《生物化学词典》、《植物学词典》、《有机化学词典》和《无机化学词典》。

在当今生命科学领域深刻变革的时代,科学界首次面临在实验室中直接实现高等生物体遗传结构改变的可能,而不是通过随机的自然选择方式。这个新时代的诞生源于20世纪70年代中期的某些重大发现,它们导致了分子遗传学新领域的出现,如广为人知的基因克隆、遗传工程及生物技术。遗传工程的核心课题是在实验室中将任意生物体的遗传物质导入微生物中,继而分离、扩增、研究这些遗传物质,以最终实现对各种特殊目的基因的工程改造。这些技术也使科学家得以更精细地研究基因及其蛋白质的结构、功能和调节机制,从而获得大量有关基因、细胞及最终的生物体在正常或疾病状态下如何发挥功能的新信息和新见解。

遗传工程技术的发展已经远远超乎人们20年前所料:遗传病相关基因的克隆;治疗性制剂、人类激素和关键血液因子在微生物“工厂”中的无限合成;遗传工程动物与植物的创建;从组织的显微样本中提取遗传学指纹图谱等。事实上,即使在本书出版之际,仅有一部分工程技术手段为人所知。

近年来,大量生物技术与遗传工程领域的研究已从理论殿堂步入了工业化流程。其使得许多新的具有潜在应用价值的研

究进入私有企业,在这里,由于更多资金的支持和市场力量的推动,新产品的研发达到了空前繁荣的地步。这也意味着科学技术的快速发展要求我们必须赶上和适应新技术的快速发展,需要不断地理解那些伴随新技术的发展而不可避免地产生的法律和伦理学问题。然而与其他新技术相比,遗传工程产品更为直接地涉及了基本的生物学过程,很自然地会对有关人类健康的所有领域产生直接而深远的影响。

编撰本词典的目的是为读者提供基本的现代生物技术和遗传工程词汇,使具备了基本生物学和生物化学知识的读者能够跟踪常见于媒体的生物技术和遗传工程的快速发展潮流。自第1版发行以来,基因调节领域已经取得了巨大的进展。许多新发现十分详尽地阐明了来自细胞环境的信号调节正常或异常细胞生长的分子机制。对多种遗传因素决定的遗传病有了更多的了解,其病因和治疗的分子术语正逐渐为人们所理解。本版进行了全面更新,以涵盖这方面的内容以及这一迅速变化领域的其他新进展。

由于本书针对不同背景的读者编写,且涉及领域广泛,因此我们试图涵盖多学科领域的基础和技术术语,包括植物学和动物学,以尽可能地满足更多读者的需求。也力求使本字典形成完整的独立体系,一些技术术语不仅显示于该条目的定义位置,也会出现于其他相关部分。期望本字典将会有益于广泛的读者群,包括高中和大学的学生、法官、医师、科学家或其他有特殊需求的读者,使他们能够同步于生物技术和遗传工程领域的快速发展。

编 者

# 译者序

诚如众多科学家所言:21 世纪是生命科学的世纪。而在生命科学领域中,最为引人注目的,则莫过于生物技术与遗传工程。经过近 40 年的发展,生物技术和遗传工程不断地从理论研究转入实际应用;从实验室走向产业化;与之相关的新产品研发方兴未艾。相对于其他新技术而言,遗传工程更直接地涉及了生物学的基本原理,其很自然地对有关人类健康的所有领域具有直接、深远的影响,也不可避免地产生了许多法律和伦理学问题。这就使得人们对生物技术与遗传工程的了解,有了极其迫切的需求。为了便于大众理解常见于各种媒体的现代生物技术和遗传工程基本词汇,使具有一般生物学与生物化学基础知识的读者能够跟踪生物技术和遗传工程方面的快速发展趋势,我们组织翻译了这本《生物技术与遗传工程词典》,以期能给大家带来学习上的些许方便和帮助。然而,由于我们的英语和专业知识水平有限,翻译中在所难免地出现了诸多错误或不确切之处,还恳请尊敬的读者能不吝赐教,并给予谅解。值此《生物技术与遗传工程词典》出版之际,我首先要向参与本书翻译、校勘工作的所有同事、同行和学生们的表示最诚挚的感谢;也要感谢促成这本书翻译、出版的世界图书出版西安公司;更要感谢为我们提供这本词典的原著作者 Mark L. Steinberg 和 Sharon D. Cosloy 教授。

宋土生

2007 年 10 月于西安

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# 凡 例

1 本词典所收录词条内容涵盖生物技术与遗传工程领域的基础术语和概念,以及在这些领域做出过重要贡献的人物的简介词条。

2 本词典的编排方式为英汉双解,采用双栏排版,左栏为英文原文,右栏为相应的中文译文。由于两种语言不同,英汉两部分的内容并非完全对应,在尊重原文的基础上,尽量贴近词条本意。

3 英文首词条和相应中文首词条的字体均采用黑体,英(汉)解释部分的字体均采用白体,若英文首词条有缩略语,则该缩略语置于英文首词条后面的括号内,中文首词条后的括号内也加入相应缩略语,例如。

**acquired immunodeficiency syndrome (AIDS)** 获得性免疫缺陷综合征(AIDS)

英文术语的其他名称置于英文首词条后面的括号内,中文的相应名称也置于中文首词条后的括号内,例如。

**acycloguanosine (acyclovir)** 无环乌苷(阿昔洛韦)

4 内容的排列顺序以英文部分首词的英文拼法顺序排列,首词后面括号中的缩略语及其他名称不参加排序。

5 词条的解释:

1)如整体释义分层次解释的,则列小标题讲解,以突出不同梯度的知识点。若从不同学科角度阐述,则学科名称置于方头括号内。个别词条有词性差别的,也置于方头括号内。例如。

**Absorption** 1 吸附(吸收) 1【病毒学】

2 2【光度学】

2)词汇中一般出现的人名不予翻译,但已约定俗成的则列出对应中文。

3)英文中的斜体、大小写均严格按相关规定书写。

4)有些词条需参照其他词条,则中英文均列出要参阅的英文词条。例如。

**absorption spectroscopy** ( See AB- 吸收光谱法 ..(参阅 **absorbance**)  
**SORBANCE**)

5)由于原文疏漏、差错等原因,造成词条解释不详或有误的,均在正确译文后的括号内以译者注的形式另行标出。例如。

**ABO blood group** and those with **ABO 血型系统** AB 型血者血清中无抗  
AB produce both Type O individuals A、抗 B 抗体, O 型血者血清中含抗 A、抗 B 抗体  
produce neither (译者注:原文有误,以译文为准)

6 正文后有 5 个附录,包括 首字母缩略词、化学元素、遗传密码、核酸中的嘌呤和嘧啶碱基、各种氨基酸的侧链。



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# A

**ABO blood group** A system of antigens expressed at the surface of human red blood cells. Human blood types represented in this group are A, B, AB, or O, depending on which antigen(s), in the form of oligosaccharides, are present at the surface of the erythrocyte membranes. The blood serum of A individuals contains anti-B antibodies, those with B type produce anti-A antibodies, and those with AB produce both. Type O individuals produce neither. This system is one of 14 different blood group systems consisting of 100 different antigens. This system is of medical importance because the recipient of a blood transfusion must receive blood that is compatible with his or her own type. Type AB individuals are known as universal acceptors, and type O individuals as universal donors. In addition, the ABO system can be used in paternity suits to rule out the possibility that a particular male is the father of the child in question.

**abscisic acid** A plant hormone, lipid in nature, synthesized in wilting leaves. It counteracts the effects of most other plant hormones by inhibiting cell growth and division, seed germination, and budding. It induces dormancy.

**absorbance** Often referred to as optical

**ABO 血型系统** 在人红细胞表面上表达的一套抗原系统。在这套系统中,根据红细胞膜表面以寡糖链形式出现的抗原的类型,将人的血型分别用 A 型、B 型、AB 型及 O 型表示。A 型血者血清中含有抗 B 抗体,B 型血者血清中含有抗 A 抗体,AB 型血者血清中无抗 A、抗 B 抗体,O 型血者血清中含抗 A、抗 B 抗体(译者注:原文有误,以译文为准)。这套血型系统是含有 100 多种抗原的 14 种血型系统中的 1 种,在医学上十分重要,因为输血时受血者必须接受与其血型相容的血液。AB 型血者是万能受血者,而 O 型血者则是万能供血者。此外,ABO 血型系统也可用于生父确认诉讼程序,以排除某位男性是孩子生父的可能。

**脱落酸** 一种天然的脂类植物激素,在树叶衰老过程中合成,可以通过抑制细胞生长和分化、种子萌发和发芽等生理过程拮抗大多数其他植物激素的作用。脱落酸还可诱导休眠。

**吸光度** 通常指光密度。吸光度

density. Absorbance is a unit of measure of the amount of light that is absorbed by a solution or by a suspension of bacterial cells. The absorbance is a logarithmic function of the percent of transmission of a particular wavelength of light through a liquid and is measured by a spectrophotometer or a colorimeter. Absorbance values are used to plot growth of suspensions of bacteria and to determine the concentration and purity of molecules such as nucleic acids or proteins in solutions.

**absorption** 1. *virology* The entry of a virus or viral genome into a host cell after the virus has absorbed to the cell surface. (See ADSORPTION.)

2. *photometry* When light is neither reflected nor transmitted, it is said to be absorbed. Some biological systems can make use of light energy because they have pigments that absorb light at specific wavelengths. These pigments are able to harness light energy to drive biochemical reactions in vivo. An example can be found in plant pigments, such as chlorophyll, that are used to trap light energy and drive the process of photosynthesis where plants manufacture nutrients.

**absorption spectroscopy** The use of a spectrophotometer to determine the ability of solutes to absorb light through a range of specified wavelengths. Every compound has a unique absorption spectrum. An absorption spectrum, which is defined as a plot of the light absorbed versus the wavelength, can be derived from a solution (See ABSORBANCE)

是测量溶液或细菌细胞悬液吸收光量的单位。吸光度用特定波长的光透过溶液的透光度的对数函数来表示,并用分光光度计或比色计来测量。吸光度常用来标识细菌悬液的生长,或者用来测定溶液中分子(如蛋白质或核酸)的浓度和纯度。

**吸附(吸收)** 1.【病毒学】病毒或病毒基因组在病毒吸附于细胞表面之后进入宿主细胞的步骤。参阅 adsorption。

2.【光度学】当光没有被反射或透射时,即表明被吸收。有些生物系统含有可以吸收特定波长光的色素,所以可以利用光能。这些色素分子在体内可以捕获光能用于驱动生化反应。以植物色素为例,如叶绿素可以捕获光能并驱动光合作用,从而制造养分。

**吸收光谱法** 使用分光光度计测定溶液对一定波长范围的光的吸收能力。每种化合物都有特定的吸收光谱。吸收光谱是用溶液的光吸收度对波长作图(参阅 absorbance)得到。吸收光谱可用于鉴别化合物、测定溶液浓度、绘制反应速率图。

Absorption spectra are used to identify compounds, determine concentrations, and plot reaction rates.

**abzymes** Catalytic antibodies that cleave proteins or carbohydrates at specific residues. They are analogous to restriction enzymes that cleave DNA at specific sequences. Catalytic antibodies have the potential to be used as therapeutic agents, attacking specific viral or bacterial surface structures, and as catalysts in reactions in which no enzyme has been found.

**acentric fragment** A fragment of a chromosome that does not contain a centromere. Because of the absence of a centromere, acentric fragments do not segregate at mitosis and eventually disappear.

**Acetobacter** A genus of gram-negative flagella-endowed bacteria that are acid-tolerant aerobic rods. They are also known as the acetic-acid bacteria due to their ability to oxidize ethanol to acetic acid. They are found on fruits and vegetables and can be isolated from alcoholic beverages. They are used commercially in the production of vinegar, but because of their ability to produce acetic acid, they are nuisance organisms in the brewing industry.

**Acetobacter aceti** An organism used in the commercial production of vinegar. When introduced into wine or cider containing 10% - 12% alcohol, it will convert to acetic acid. See ACETOBACTER.

**抗体酶** 也称催化性抗体,可在特定基团裂解蛋白质或糖类。它们与在特定序列处裂解 DNA 的限制性内切酶类似。催化性抗体有可能作为治疗药物,攻击病毒或细菌表面的特定结构,并且在没有酶存在的反应中作为催化剂。

**无着丝粒片段** 缺乏着丝粒的染色体片段。由于缺乏着丝粒,无着丝粒片段在有丝分裂中不分离和最终丢失。

**醋杆菌属** 具鞭毛的革兰阴性菌的一个属,为需氧、耐酸杆菌。该属细菌也因为可将乙醇氧化为乙酸而被称做乙酸菌。见于水果或蔬菜中,可从酒精饮料中分离。在商业上常用于醋的生产,但由于可产生乙酸,因此在酿造工业中是一类有害生物。

**醋化醋杆菌** 商业上用于生产醋的一种菌,在含 10% ~ 12% 乙醇的葡萄酒或苹果酒中,可将乙醇转化为乙酸。参阅 *Acetobacter*。

**acetone-butanol fermentation** The anaerobic fermentation of glucose by *Clostridium acetobutylicum* to form acetone and butanol as end products. At one time, the production of these commercially important chemicals relied on bacterial fermentation, but this has since been replaced by chemical synthesis.

**acetylcholine** A chemical neurotransmitter that is expelled into the synaptic cleft, or space between two nerve cells. This neurotransmitter permits the transmission of an electrical nerve impulse or action potential from one nerve cell to another by diffusing across the cleft and then binding to a cell-membrane receptor.

**acetylcholinesterase** An enzyme present in the synaptic cleft, or space between two nerve cells, that hydrolyzes or destroys the unbound neurotransmitter acetylcholine once it has diffused through the cleft. This is required to restore the synaptic cleft to a state that is ready to receive the next nerve impulse. See ACETYLCHOLINE.

**acid blobs** Certain sequences of amino acids on a protein that bind to a transcriptional regulatory protein and, in so doing, serve to activate transcription.

**acid growth hypothesis** The hypothesis that elongation of plant cells caused by the plant hormones known as auxins involves a mechanism for creating an acid environment (lowered pH) in the specific region of the cell where growth is to occur. The acidifica-

**丙酮-丁醇发酵** 葡萄糖在梭状芽孢杆菌作用下经厌氧发酵形成最终产物丙酮或丁醇。这两种在商业上很重要的化学物质曾经主要依赖细菌发酵产生,但现在已被化学合成所代替。

**乙酰胆碱** 一种释放在突触间隙或两个神经细胞间的化学神经递质。这种神经递质可以通过突触间隙扩散并结合于细胞膜上的受体,从而在神经细胞间传递电神经冲动或动作电位。

**乙酰胆碱酯酶** 存在于神经细胞间或者突触间隙的一种酶,水解或破坏在突触间隙扩散后没有结合的乙酰胆碱。这对于恢复突触间隙到接受下一次神经冲动的状态是必要的。参阅 acetylcholine.

**酸性区** 蛋白质上特定的氨基酸序列,可以与转录调控蛋白结合,从而激活转录。

**酸生长假说** 一种关于植物激素(即所谓“生长素”)诱导细胞延伸生长的假说,即生长素在细胞的特异区域诱导产生低 pH 的酸性环境,促使细胞生长。植物细胞局部区域的酸化作用有助于解释植物的某些趋向行为,如向光性。

tion of a plant cell in a localized region helps account for certain tropic behaviors seen in plants, for example, phototropism.

**acidic amino acids** The two amino acids that are negatively charged at pH 7.0 are aspartic and glutamic acids. Also referred to as aspartate or glutamate. Both of these amino acids contain in their R or variable groups a second carboxyl group that is ionized under physiological conditions.

**acidophile** A classification of microorganisms that describes the ability or the necessity of certain species to exist in an acidic environment. These acid-loving organisms can exist at a pH range of 0 ~ 5.4, well below the optimum of neutrality for most bacteria. Facultative acidophiles can tolerate a range of pH from low to neutral and include most fungi and yeasts. However, obligate acidophiles including members of the genera *Thiobacillus* and *Sulfolobus* require low pH for growth. A neutral pH is toxic to these species.

**acquired immunodeficiency syndrome (AIDS)** An infectious disease in humans caused by the human immunodeficiency virus (HIV). The virus attacks the host's immune system leaving him/her susceptible to many other diseases, including certain rare forms of cancer and opportunistic microbial infections that would otherwise be destroyed in an uninfected individual. Most often, AIDS patients die from these secondary infections that run rampant through the body because of the loss of ability to immunologically suppress

**酸性氨基酸** 指在 pH 7.0 时带负电荷的氨基酸天冬氨酸和谷氨酸。酸性氨基酸也指天冬酰胺和谷氨酰胺。在生理条件下,这两类氨基酸的 R 基团或可变基团中含有第二个被离子化的羧基。

**嗜酸性细菌** 一种微生物学分类,用于描述某种微生物能够或必须在酸性条件下生存。这些嗜酸性微生物可在 pH 为 0 ~ 5.4 的条件下生存,大大低于适合大多数细菌的最适中性环境。兼性嗜酸菌对 pH 的耐受范围可以从低到中性,包括大多数真菌和酵母菌。然而,专性嗜酸菌(包括硫杆菌属、*Sulfolobus* 等)则需要较低的 pH 才能生长,中性 pH 环境对于这类微生物来说是有毒性作用的。

**获得性免疫缺陷综合征(AIDS)**

由人免疫缺陷病毒(HIV)引发的一种人类传染性疾病。病毒攻击宿主免疫系统,使其对其他疾病易感,包括某些罕见的癌症、机会性微生物感染(这种微生物感染在正常个体中受到抑制)。大多数情况下,AIDS 患者因丧失免疫系统对感染的抑制能力而死于扩散至全身的继发性感染。HIV 病毒可在与感染个体性接触中通过体液传播,或因与其他静脉注射药品者共用同一针头、输注污染的血液制品(由于已经可以对捐赠血进行检测而避免)及分娩

them. The HIV virus is transmitted through the exchange of body fluids during sexual contact with an infected individual, the sharing of needles among intravenous drug users, transfusion of contaminated blood products (no longer a threat due to the ability to screen donated blood), and from mother to newborn during delivery. It has not been shown to be transmitted through casual contact with infected individuals.

**acridine orange** One of a group of chemical mutagens known as acridines, including proflavin and acriflavine. The size of the acridines is the same as that of a purine-pyrimidine base pair. For this reason, they can insert or intercalate into the helix between two adjacent base pairs. When DNA that contains an intercalated acridine is replicated, an additional base pair may be added or a base pair may be deleted, disrupting the codon reading frame in the newly synthesized strand. Such a mutation is called a frameshift mutation.

**acrosome** (process, reaction, vesicle) A vesicle- or membrane-bound compartment covering the sperm head that contains lytic enzymes. The major enzyme found in the mammalian sperm acrosome is hyaluronidase, which promotes the digestion of the tough outer coat of the egg and allows penetration of the sperm.

**acrylamide** A substance that can polymerize and form a slab gel when poured into a mold in its molten state. It is used as

时母婴传播等途径传播。没有证据显示与患者偶然接触可导致感染。

**吖啶橙** 一种吖啶类化学诱变剂,包括原黄素和吖啶黄素。吖啶类化合物的大小与嘌呤-嘧啶碱基对的大小相近,因此它们可以嵌入或插入DNA双螺旋的两个相邻碱基对之间。当含有插入吖啶的DNA复制时,可能会增加或丢失一个碱基对,从而破坏新合成链的密码阅读框。这种突变称做移码突变。

**顶体**(生成、反应、顶体泡) 泡状或者由膜包被的覆盖精子头部的结构,内含裂解酶类。在哺乳动物精子的顶体中发现的最重要的酶为透明质酸酶,其可促进卵细胞外被溶解,从而利于精子进入卵细胞。

**丙烯酰胺** 一种在溶解状态下倒入模具后可以聚合形成凝胶的化学物质。经常被用做半固体的支持介

semisolid support medium and is immersed in a conductive buffer through which a current is passed. When solutions containing heterogeneous mixtures of nucleic acid fragments or mixtures of proteins are placed into slots in the gel and subjected to the electrical current, the nucleic acid or protein mixtures may be separated into distinct collections of homogeneous molecules located in different regions of the gel, based on their size or molecular weight. See ELECTROPHORESIS.

**ACTH** (adrenocorticotrophic hormone) A polypeptide hormone secreted by the anterior portion of the pituitary gland. ACTH stimulates the growth of the adrenal cortex as well as the production of a number of steroid hormones (e.g., cortisol) in the adrenal cortex.

**actin** One of the two major proteins responsible for muscle contraction. Actin and myosin are found in smooth and striated muscle. Actin monomers together with two other proteins, troponin and tropomyosin, can polymerize to form long, thin filaments that, together with myosin filaments, can shorten in the presence of ATP (adenosine triphosphate). Actin also plays a role in the shape and structure of cells.

**Actinomyces** A genus of anaerobic gram-positive rods that are often found in the mouth and throat. They occasionally display a branched filamentous morphology. Many, such as *A. israelii*, are human pathogens.

**Actinomycin D** An antibiotic produced by *Streptomyces parvullus* that inhibits RNA

质,置于导电的缓冲液中。当含有不同核酸片段或蛋白质混合物的溶液被置于凝胶的胶槽并通电时,核酸或蛋白质混合物可因大小或分子量不同,在凝胶的不同区域分离形成清晰同类分子富集条带。参阅 electrophoresis.

**促肾上腺皮质激素 (ACTH)** 一种由垂体前叶分泌的多肽类激素。促肾上腺皮质激素可促进肾上腺皮质生长及皮质类固醇在肾上腺皮质中的生成。

**肌动蛋白** 参与肌肉收缩的两种主要蛋白中的一种,肌动蛋白和肌球蛋白见于平滑肌和横纹肌中。肌动蛋白单体与其他两种蛋白(肌钙蛋白和原肌球蛋白)聚合形成细长的纤维,在ATP(三磷酸腺苷)的参与下,与肌球蛋白纤维共同导致收缩。肌动蛋白在维持细胞的形状和结构中亦有重要作用。

**放线菌** 一种革兰阳性厌氧杆菌,常见于口腔或咽喉部位。偶呈丝状分支形态。许多放线菌如 *A. israelii* 等是人类致病病原体。

**放线菌素 D** 一种由 *Streptomyces parvullus* 产生的可以抑制原核生物



transcription in both prokaryotes and eukaryotes. It blocks the action of RNA Polymerase I, which synthesizes ribosomal RNA, and forms complexes with DNA by intercalating between G-C pairs, preventing the movement of DNA- and RNA-synthesizing enzymes. Although toxic, it is sometimes used in conjunction with other drugs as a chemotherapeutic agent, due to its antitumor properties.

**action potential** Also called a nerve impulse; sequential wave of depolarization and repolarization across the membrane of a nerve cell (neuron) in response to a stimulus. Depolarization is a reversal in the distribution of charge between the inside and the outside of the neuron membrane.

**activated sludge process** A secondary sewage-treatment process where biological processing of the sewage by microbial activity is the main method of treatment. In this step, sewage that has been previously treated in settling tanks is aerated in large tanks to encourage growth of microorganisms that oxidize dissolved organics to carbon dioxide and water. Bacteria, yeasts, molds, and protozoans are used. This process proves effective in reducing intestinal pathogens in sewage while encouraging growth of nonpathogens. After activated sludge has been produced, additional processing is required, including anaerobic digestion, filtering, and chlorination.

**activation energy** The energy required for a chemical reaction to proceed. In biological

和真核生物 RNA 转录的抗生素。它可以抑制合成核糖体 RNA 的 RNA 聚合酶 I 的活性,或嵌入 DNA 的 G-C 碱基对间形成复合物,从而抑制 DNA 和 RNA 聚合酶的活性。虽然有毒性,但由于其抗癌特性,常作为化疗药物与其他药物联合使用。

**动作电位** 也称神经冲动,是神经细胞膜对刺激产生的有次序的去极化和复极化波。去极化是指神经细胞膜内外电荷分布的逆转。

**活性污泥处理** 二级污水处理步骤,主要以微生物进行污水生物处理。在这步处理中,将在沉淀池沉淀后的污水充气,从而促进微生物生长,后者可以氧化分解有机质形成 CO<sub>2</sub> 和水。细菌、酵母、霉菌、原生动物等皆可以使用。这步处理已经证明对于减少污水中的肠道病原体、促进非病原体生长有效。活性污泥产生后,进一步的处理包括厌氧消化、过滤、氯化杀菌等。

**活化能** 发生化学反应所需要的能量。在生物系统中,酶可以降低反应的活化能,使生理条件下的化