高等学校教材

生物工程 生物技术 专业英语

大学英语专业阅读教材编委会组织编写

◎华东理工大学 邬行彦 储炬 宫衡 编

◎浙江大学 朱自强 主审

化学工业出版社

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全国部分高校化工类及相关专业
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前　言

组织编审出版系列的专业英语教材，是许多院校多年来共同的愿望。在高等教育面向21世纪的改革中，学生基本素质和实际工作能力的培养受到了空前重视。对非英语专业的学生而言，英语水平和能力的培养不仅是文化素质的重要部分，在很大程度上也是能力的补充和延伸。在此背景下，教育部（原国家教委）几次组织会议研究加强外语教学问题，并制定有关规范，使外语教学更加受到重视。教材是教学的基本要素之一，与基础英语相比，专业英语教学的教材问题此时显得尤为突出。

国家主管部门的重视和广大院校的呼吁引起了化学工业出版社的关注，他们及时地与原化工部教育主管部门和全国化工类及相关专业教学指导委员会请示协商后，组织全国十余所院校成立了大学英语专业阅读教材编委会。在经过必要的调研后，根据学校需求，编委会优先从各校教学（交流）讲义中确定选题，同时组织力量开展编审工作。本套教材涉及的专业主要包括化学工程与工艺、石油化工、机械工程、信息工程、生产过程自动化、应用化学及精细化工、生物工程、环境工程、制药工程、材料科学与工程、化工商贸等。

专业英语是学生完成了两年基础英语学习后的一门后继课程。《大学英语专业阅读阶段教学基本要求（试行）》(1996)（以下简称《基本要求》）提出的目的是“通过指导学生阅读有关专业的英语书刊和文献，使他们进一步提高阅读和翻译英语科技资料的能力，并能以英语为工具获取专业所需的信息”。在科技领域，英语的重要性日益突出，生物工程领域尤为如此：重要的有关生物工程的期刊，都要求以英语发表；重要的国际会议都以英语为工作语言。

华东理工大学生化工程系在于接芸老师的领导和主持下，在90年代初即开始重视专业英语教材的建设，组织教师选编教材，注意内容广泛、系统覆盖整个专业，语言规范、体裁文笔多样，经过几次比较试用，选择了几本科普原版书籍，编写了词汇表和注释。学生反映较好，英语能力经调查也有较大提高。

1996年化学工业出版社曾在几所高校中，对专业英语的编写工作进行过问卷调查。调查结果主要有三点：①编写教材的原则应有利于学生通过专业知识学英语；②教材内容不求新，但应有代表性，且覆盖面宽，以便于学生扩大专业词汇量；③课文难度应相当于科普读物，且略难于科普读物。我们觉得这三点意见提得正确、中肯，纠正了我们长期以来对专业外语教材的模糊认识。由于我们都是专业教师，很自然地看重于专业知识，而忽视语言知识。由此，我们对原教材作了较大修改，精简了一些有关近代生物工程的部分，但保留了专业的基本内容，使篇幅压缩在可允许的范围内，并重点加强了科技英语的语言基础和应用能力的培

养，努力把英语与专业结合起来，以专业为背景，分析科技英语的各种表示方法。修改后的教材有如下特点。

1. 均选自原版英文科普书籍

（1）第1、3、4、5章选自J. E. Smith著“Biotechnology Principles”一书，1985年Van Nostrand Reinhold公司出版。该书属科普读物，英语规范，内容全面，涉及生物工程的主要内容。

（2）第2、6、7、8、9章选自J. D. Bu' Lock和B. Kristiansen主编“Basic Biotechnology”一书：1987年Academic Press出版，也是一本科普书，但内容比上一本稍深，各章由不同作者编写，文笔各异。第一本书没有生物化学方面的内容，检测仪表的叙述过于简单；第二本书的第2章和第7章补充了第一本的不足，并介绍了较新的动植物细胞培养的技术（第8、9章）。

2. 提高阅读理解能力

培养阅读理解能力是《基本要求》规定的目的之一，为此，本教材采取的措施有：①将难句作为英译中习题，并要求从文法上进行句子分析；②对难理解的关键词，作为习题要求给出英语解释；③介绍必要的专业背景知识。经验表明，学生对课文不能理解或理解不深，往往是缺乏有关专业背景的缘故。由于学生在第5学期还未接触到专业，为帮助理解课文，给出科普性质的注释（Notes）共32条。同时各章还附有理解题（Comprehension），题目内容覆盖整个章节，且难度适中，主要在于督促学生阅读，检查对专业内容理解的程度。

3. 包含了科技英语中主要的语法，句和词与词组的用法

所有语法及词的用法均在课文中出现时作出注释，或结合课文以习题的形式提出，达到提高语言基础的目的。这些内容汇总在附录3中，便于查找。

4. 重视词汇，书后附有详细的词汇表

全书课文约含10万字词，能在课堂上讲授的约6～7万（按每学时讲解800词，总学时数为72～90计算），即有约1/3的课文需学生在课外自学，而生物工程作为一门新兴学科，是几门学科的交叉，词汇范围广，分布在各类字典。为帮助学生自学查阅，文后附有详尽的词汇表，并注有音标和相应的页码和行次。对意义易混淆生词，除附英语解释外，还适当附同义词，以扩大词汇，但不包括大学英语大纲1～4级词汇。书末附有总词汇表，共计约1200个条目，符合《基本要求》的规定。为帮助学生记忆生词，了解前缀、后缀和构词成分，附录1和附录2分别列举书中遇到的常用前、后缀和化学、化工、生物方面的前、后缀。

5. 重视写作能力的培养

写作能力的培养主要依赖于实践，本书的大量习题都选自专业文献，选择科技论文摘要、引言或写作中所需表达的一些实验操作、装置和讨论方式，且文字较规范的译成中文，要求学生重新译成英文。书末还附有一些中译英习题，可供教师选用。

本书承浙江大学朱自强教授在百忙中审校了全书，提出了宝贵的意见；华东理工大学外语系周志培教授审阅了有关语法方面的注释，并提出了一些修改意见；华东理工大学专业英语教学指导委员会前任主任朱思明教授对本书给予关注并提出了一些意见；对此，我们一并表示深切的谢意。

本书不仅得到化学工业出版社和华东理工大学教务处的大力支持，还得到大学英语阅读教材编审委员会主任委员华东理工大学朱炳辰教授和副主任委员华南理工大学钟理教授的关心和帮助，我们也表示诚挚的谢意。

本书可作为生物工程、生物技术专业英语的教材，内容涉及整个生物工程领域，相当于专业概论，也可作为生物工程技术人员学习英语或其他科技人员了解生物工程的入门参考书。

本书的编写工作历经数年，在结合多年的教学实践的基础上，参阅了大量科技英语和专业方面书刊，但由于生物工程领域宽，学科面广，以及限于作者水平，错误之处在所难免，还望读者指正，不胜感谢。

编　者

一九九九年五月

内 容 提 要

《生物工程/生物技术 专业英语》是根据《大学英语专业阅读阶段教学基本要求（试行）》而编写的，本书可供理工科院校生物工程专业、生物技术专业及相关专业学生使用，也可作为生物工程技术人员学习英语或其他科技人员了解生物工程的入门参考书。

本书共分9章，约10万词，内容选自两本著名的生物工程科普书，系统性强，覆盖生物工程的主要领域，包括：微生物生长和代谢的生物化学，诱变育种，基因重组，发酵，酶和固定化细胞技术，产品回收，检测仪表，动、植物细胞培养等。

本书力求将英语与专业紧密结合，通过专业阅读提高英语基础及其应用能力。本书的特色在于：1. 对专业内容给出科普性质的注释以帮助阅读理解；2. 结合课文给出注释或以习题形式介绍科技英语中常用的或易混淆的语法、词与词组的用法、句型等；3. 附有详尽的词汇表并注有音标；4. 习题量多，包括释义、辨义、造句、翻译和写作等，翻译习题取自课文，写作习题取自专业文献，重点在专业论文或摘要的常用表示方法。

目　　录

Chapter 1 Introduction

1.1 The nature of biotechnology

Biotechnology is an area of applied bioscience and technology which involves the practical application of biological organisms, or their subcellular components to manufacturing and service industries and to environmental management①. Biotechnology utilizes bacteria, yeasts, fungi, algae, plant cells or cultured mammalian cells as constituents of industrial processes. Successful application of biotechnology will result only② from the integration of a multiplicity of scientific disciplines and technologies, including microbiology, biochemistry, genetics, molecular biology, chemistry and chemical and process engineering.

Biotechnological processes will normally involve the production of cells or biomass, and the achievement of desired chemical transformations. The latter may be further subdivided into:

(a) formation of a desired end product (e. g. enzymes, antibiotics, organic acids, steroids);

(b) decomposition of a given starting material (e. g. sewage disposal, destruction of industrial wastes or oil spillages).

The reactions of biotechnological processes can be catabolic, in which complex compounds are broken down to simpler ones (glucose to ethanol), or anabolic or biosynthetic, whereby simple molecules are built up into more complex ones (antibiotic synthesis). Catabolic reactions are usually exergonic whereas anabolic reactions are normally endergonic.

Biotechnology includes fermentation processes (ranging from beers and wines to bread, cheese, antibiotics and vaccines), water and waste treatment, parts of food technology, and an increasing range of novel applications ranging from biomedical to metal recovery from low grade ores. Because of its versatility, biotechnology will exert a major impact in many industrial processes and in theory almost all organic materials could be produced by biotechnological methods. Predictions of future worldwide market potential for biotechnological products in the year 2000 have been estimated at nearly US $65bn (Table 1.1). However, it must also be appreciated that many important new bio-products will still be synthesized chemically from models derived from existing biological molecules, e. g., new drugs based on the interferons③. Thus the interface between bioscience and chemistry and its relationship to biotechnology must be broadly interpreted.

A high proportion of the techniques used in biotechnology tend to be more economic,

less energy demanding④ and safer than current traditional industrial processes and for most processes the residues are biodegradable and non-toxic. In the long term biotechnology offers a means of solving some major world problems, in particular those related to medicine, food production, pollution control and the development of new energy sources.

Table 1.1 Growth potential for worldwide biotechnological markets by the year 2000

Market sector	$ (million)
Energy	16 350
Foods	12 655
Chemicals	10 550
Health care(pharmaceuticals)	9080
Agriculture	8546
Metal recovery	4570
Pollution control	100
Other(i.e. unexpected developments)	3000
Total	64 851

From T. A. Sheets Co. (1983). *Biotechnology Bulletin* November.

1.2 Historical evolution of biotechnology

Contrary to popular belief biotechnology is not a new pursuit but in reality dates far back into history. In practice, four major developmental phases can be identified in arriving at modern biotechnological systems.

Biotechnological production of foods and beverages Activities such as baking, brewing and wine making are known to date back several millenia; the ancient Sumarians and Babylonians were drinking beer by 6000 B. C., the Egyptians were baking leavened bread by 4000 B. C. while wine was known in the Near East by the time of the book of Genesis. The recognition that these processes were being affected by living organisms, yeasts, was not formulated until the 17th century, by Anton van Leeuwenhoek. Definitive proof of the fermentative abilities of these minute organisms came from the seminal studies of Pasteur between 1857 and 1876. Pasteur can justifiably be considered as the father of biotechnology.

Other microbially based processes such as the production of fermented milk products, e. g. cheeses and yogurts, and various oriental foods, e. g. soy sauce, tempeh etc., can equally claim distant ancestry. Of more recent introduction is mushroom cultivation which probably dates back many hundreds of years for Japanese shii-ta-ke cultivation and about 300 years for the *Agaricus* mushroom now widely cultivated throughout the temperate world.

It cannot be ascertained whether these microbial processes arose by accidental observation or by intuitive experimentation but their further and continued development were early examples of man's abilities to use the vital activities of organisms for his own needs. In more recent times, just as these processes have become more reliant on advanced technology, their contribution to world economy has equally increased out of all proportion to their humble origins.

Biotechnological processes initially developed under non-sterile conditions Many important industrial compounds such as ethanol, acetic acid, organic acids, butanol and acetone were being produced by the end of the 19th century by microbial fermentation procedures that were open to the environment; the control of contaminating micro-organisms was achieved by careful manipulation of the ecological environment and *not* by complicated engineering practices. However, with the arrival of the petroleum age in which these compounds could be produced more cheaply from the by-products of petroleum production, most of these emerging industries were eclipsed. Escalation of oil prices in recent years has lead to a re-examination of the early fermentation procedures with a view to a return to commercial production. Together with the previously mentioned food fermentations these fermentation practices are relatively simple and can be run on a large scale.

Other outstanding examples of non-sterile biotechnology are waste water treatment and municipal composting of solid wastes. Microorganisms have long been exploited for purposes of decomposing and detoxifying human sewage and, to a lesser extent, in the treatment of industrial toxic wastes such as those from the chemicals industry. Biotechnological treatment of waste waters represents by far the largest (but least recognised) fermentation capacity practised throughout the world (Table 1.2)[6].

Table 1.2 Total UK fermentation capacity

Product	Total capacity (m^3)
Waste water	2800000
Beer	128000
Baker's yeast	19000
Antibiotics	10000
Cheese	3000
Bread	700

From Dunnill (1981).

The introduction of sterility to biotechnological processes A new direction in biotechnology came in the 1940s with the introduction of complicated engineering techniques to the mass cultivation of micro-organisms to ensure that the particular biological process could proceed with the exclusion of contaminating microorganisms. Thus by prior sterilization of the medium and the bioreactor and with engineering provision for the exclusion of incoming contaminants only the chosen biocatalyst was present in the reactor. Examples of such products, which represent an increasing volume of biotechnological activity, include antibiotics, amino acids, organic acids, enzymes, steroids, polysaccharides and vaccines. Most of these processes are complicated, expensive and suitable only for high value products. Although many of the products are produced in relatively large quantities they are still dwarfed in volume and financial returns by the older systems used in food and beverage biotechnology (Table 1.3).

New dimensions and possibilities for biotechnological industries Within the last decade there have been outstanding developments in molecular biology and process control which have created new and exciting opportunities not only to create new dimensions but

Table 1.3 UK fermentation industry sales

Industry	Sales (£m)
Brewing	3190
Spirits	1860
Cheese	415
Cider, wine	190
Bread	150
Antibiotics	100
Yogurt	65
Yeast	25
Citric acid	20

From Dunnill(1981).

also to improve greatly the efficiency and economics of the established biotechnological industries. It is largely from these discoveries and developments that there have been such euphoric statements about the future role of biotechnology to the world economy.

What then are these new innovations? (Table 1.4).

Table 1.4 Techniques stimulating the development of biotechnology

Recombinant DNA manipulation
Tissue culture
Protoplast fusion
Monoclonal antibody preparation
Protein structural modification('protein engineering')
Immobilized enzyme and cell catalysis
Sensing with the aid of biological molecules
Computer linkage of reactors and processes
New biocatalytic reactor design

(a) *Genetic engineering*. Manipulation of the genome of industrially important organisms by sexual recombination and/or by mutution have long been part of the innovative repertoire of the industrial geneticist. New recombinant DNA techniques involve breaking living cells gently, the extraction of DNA, its purification and subsequent selective fragmentation by highly specific enzymes; the sorting, analysis, selection and purification of a fragment containing a required gene; chemical bonding to the DNA of a carrier molecule and the introduction of the hybrid DNA into a selected cell for reproduction and cellular synthesis. Recombinant DNA technologies permit easier manipulation of a genome and can readily bypass interspecies and intergeneric incompatability. Unlimited possibilities exist and already human insulin and interferon genes have been transferred into and expressed by microbial cells. Protoplast fusion, monoclonal antibody preparation and the wide use of tissue culture techniques including the regeneration of plants from suspension culture cells have had a profound impact on the development of biotechnology. (Chapter 3).

(b) *Enzyme technology*. Isolated enzymes have long been a part of many biotechnol -

ogical processes and their catalytic properties are being further utilized with the development of suitable immobilization techniques allowing reuse of the biocatalyst. Of particular importance has been the development of high fructose syrups (annual production 3 million tonnes) using immobilized bacterial glucose isomerase. A further development is the immobilization of whole cells for biocatalytic purposes (Chapter 5).

(c) *Biochemical engineering*. Bioreactors play a central role in biotechnological processes by providing a link between the starting materials or substrates and final products (Fig. 1.1; Chapter 4). Major advances have been made in bioreactor designs, in process monitoring techniques and in computer control of fermentation processes. However, the application of process control in biotechnological industries is many years behind that in operation in the chemical process industry. New approaches to the processing of the products of biotechnology (downstream processing) will improve the economics of all processes. There is an increasing need to design efficient recovery processes, in particular for high value products e. g. the ratio of recovery to fermentation costs for L-asparaginase is about 3.0 whereas for ethanol it is 0.16. However, downstream processing is still the Cinderella subject of biotechnology.

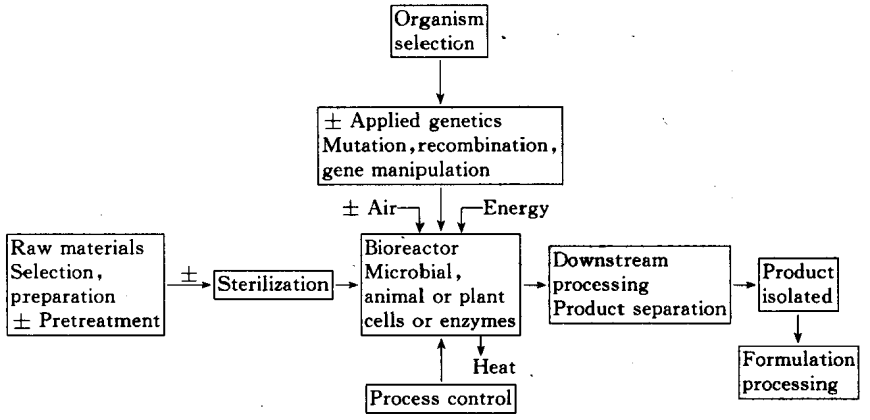

Fig. 1.1 Schematic overview of a biotechnological process

(d) *Engineered products/systems*®. The ability to produce in quantity biological molecules such as antibodies or enzymes together with the techniques of protein and cell immobilization are allowing the development of radically new sensors that can be used for biodiagnostic, and biodetoxification, purposes. Such systems can be combined with micro-electronic devices and ultimately computers allowing sophisticated control programming in many biotechnological industries and services.

Biotechnology has two characteristic features: its connection with practical applications, and interdisciplinary cooperation. The practitioners of biotechnology will employ techniques derived from chemistry, microbiology, genetics, biochemistry, chemical engineering and computer science , and their main mission will be the innovation, development and optimal operation of processes in which biochemical catalysis has a fundamental and irreplaceable role. Biotechnology does not constitute a new

discipline but rather is an activity in which specialists from a wide range of disciplines can make their contributions.

A clear distinction must be drawn between bioscience and biotechnology. Bioscience refers to acquisition of biological knowledge whereas biotechnology refers to application of biological knowledge. Biotechnological processes will, in most cases[7], function at low temperatures, will consume little energy and rely in general on inexpensive raw materials as substrates.

Bioscientists and engineers of various specializations will make their individual contributions to biotechnology. The term *biotechnologist* has crept into our vocabulary as an all-embracing description of scientists or engineers engaged in applying their skills and knowledge to the *processing* of biological materials. However, the use of this term should be discontinued as it can only lead to confusion. In contrast a *biochemical engineer* is a process engineer whose role is to *transfer* the knowledge of the biological scientist into a practical operation. A biochemical engineer will have been trained in the scientific and engineering principles underlying the design and operation of biological operations[8].

A 'complete biotechnologist' will never exist, since no one can be expert in the skills of microbiology, biochemistry, molecular biology, chemical and process engineering, etc. However, for those who practise in this subject every effort must be made to understand the language of the other component subjects. The lack of a common language between specialists in different disciplines is undoubtedly the major obstacle in realising the full potential of biotechnology.

1.3 Application of biotechnology

Biotechnological processes can be considered on the basis of volume and value. Thus, high volume, low value products or services include water purification and effluent and waste treatment and the production of methane, ethanol, biomass and animal feed; relatively high volume, intermediate value products include amino acids and organic acids, food products, baker's yeast, acetone, butanol and certain polymers, while low volume, high value products include antibiotics, interferons, vaccines, monoclonals, antibodies, enzymes and vitamins. Biotechnology can also be considered in terms of the levels of technology that will be necessary for product formation (Table 1.5).

With reference to the scale of industrial development rather than the size of the individual production units, present and future biotechnology can also be conveniently divided into three areas.

(a) *Small scale biotechnology* is specifically concerned with biochemical products that can be produced economically only by biological means. This type of biotechnology has long existed and is rapidly developing, particularly in areas of new and novel products, but there exists fierce competition between industrial concerns to achieve market advances. Product examples include antibiotics, monoclonal antibodies and interferons.