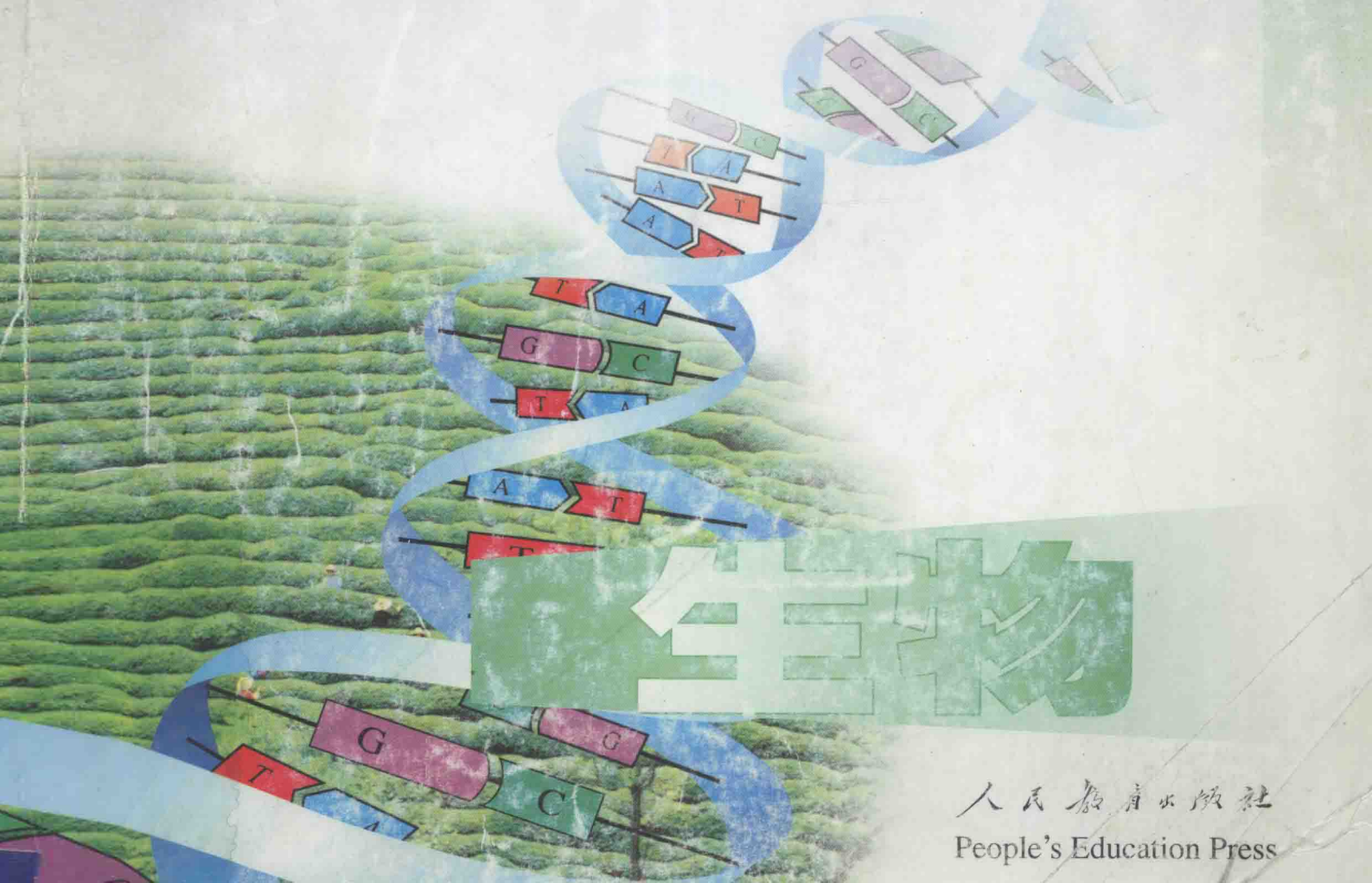
英语版

全日制普通高级中学教科书（试验修订本·必修）

BIOLOGY

第二册

课程教材研究所
双语课程教材研究开发中心 组译



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说　明

随着改革开放的不断扩大，中国在经济、文化、教育等诸多方面与各国间的交往日益增强，中国人学习英语的热情也日趋高涨。当今社会，是否熟练掌握英语，已成为衡量一个人的知识结构甚至综合素质的一个重要方面。在这样的形势下，多角度、多渠道提高人们的英语水平，特别是提高基础教育阶段在校高中学生的英语水平，已经成为社会的迫切需要。

为了适应这种新的形势和需要，作为教育部直属单位的课程教材研究所着手研究开发这套英语版普通高中教材，包括数学、物理、化学、生物、历史、地理六门必修课程，由人民教育出版社出版。

这套英语版高中教材，根据经国家教育部审查通过、人民教育出版社出版的《全日制普通高级中学教科书（试验修订本·必修）》翻译而成，主要供实行双语教学的学校或班级使用，也可以作为高中生的课外读物，其他有兴趣的读者也可以作为参考书使用，使学科知识的掌握与英语能力的提高形成一种双赢的局面。

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2002年6月

高中《生物》教科书

说　明

一、《全日制普通高级中学教科书（试验修订本·必修）生物》是根据教育部2000年颁布的《全日制普通高级中学课程计划（试验修订稿）》和《全日制普通高级中学生物教学大纲（试验修订版）》的规定，遵照1999年全国教育工作会议的精神，在两省一市进行试验的《全日制普通高级中学教科书（试验本）·生物（必修）》的基础上进行修订的。此次修订的指导思想是：遵循“教育要面向现代化，面向世界，面向未来”的战略思想，贯彻教育必须为社会主义现代化建设服务，必须与生产劳动相结合，培养德、智、体、美全面发展的社会主义事业的建设者和接班人的方针，以全面推进素质教育为宗旨，全面提高普通高中教育质量。

普通高中教育，是与九年义务教育相衔接的高一层次的基础教育。高中教材的编写，旨在进一步提高学生的思想道德品质、文化科学知识、审美情趣和身体心理素质，培养学生的创新精神、实践能力、终身学习的能力和适应社会生活的能力，促进学生的全面发展，为高一级学校和社会输送素质良好的合格的毕业生。

二、本书分为两册，分别供高中二年级学生第一学期和第二学期使用。本书的教学内容分为必学和选学。选学内容除教材中明确标出“选学”和“选做”的以外，还包括正文中以小号字编排的内容。

三、本书根据教学大纲规定，配有与教学内容相关的实验、实习和研究性课题共26个。实验要求学生在课堂上完成，实习和研究性课题需要学生在课堂教学之外完成。

四、本书设有“演示实验”、“小资料”、“课外读”及“课外生物科技活动”等栏目。设置上述栏目的目的是为了开阔学生视野，启发学生思考，提高学生的学习兴趣和培养学生的多种能力，教师应鼓励学生尽可能完成。

五、本书教学内容和行文中使用的量和单位，是依据国家技术监督局颁布的《中华人民共和国国家标准GB 3100～3102—93量和单位》。

六、本书的试验本由叶佩珉、赵占良主持编写工作，编写人员是赵占良、叶佩珉、刘真、张军、柴西琴、王真真、李红（按执笔章节顺序），责任编辑是王真真，审定者是叶佩珉。

参加本书讨论的有朱正威、郑春和、曹保义、刘启宪、王惠弟、刘毓森、陈志祺等。

七、参加本书修订的执笔人是赵占良、王真真、刘真、张军、柴西琴、谭永平、李红（按执笔章节顺序），责任编辑是王真真。

八、本书的美术编辑是林荣桓，参加图稿绘制的有李宏庆、林荣桓、高巍、郑文娟、张蓓、何慧君、杨文杰、姜吉维、郭威等。为本书提供照片的有刘俊波、蔡惟年、董志刚、崔丽筠、蒋卫杰、宋世君、王润生、刘录祥、李都、邓佳、肖尊安、国家863计划生物领域、国家海洋局、教育部教学仪器研究所等。为本书摄影的有关锡良、石磊等。

九、本书在编写过程中得到了许多专家、教师和教学研究人员的大力支持和帮助。北京大学翟中和院士、吴鹤龄教授、吴相钰教授、陈守良教授、王镜岩教授，北京师范大学孙儒泳院士、王玢教授、彭奕欣教授，国家环境保护局任耐安同志，以及北京医科大学金明教授，分别审阅了有关章节的初稿。天津市教育教学研究室和天津市南开中学等单位为本书中的实验、实习等项目做了大量的工作，提供了有利条件。在此一并表示衷心的感谢。在本书试用期间，欢迎广大师生和读者提出宝贵的意见和建议。

本册教材经教育部中小学教材审定委员会审读，尚待审查。

人民教育出版社生物自然室

2000年11月

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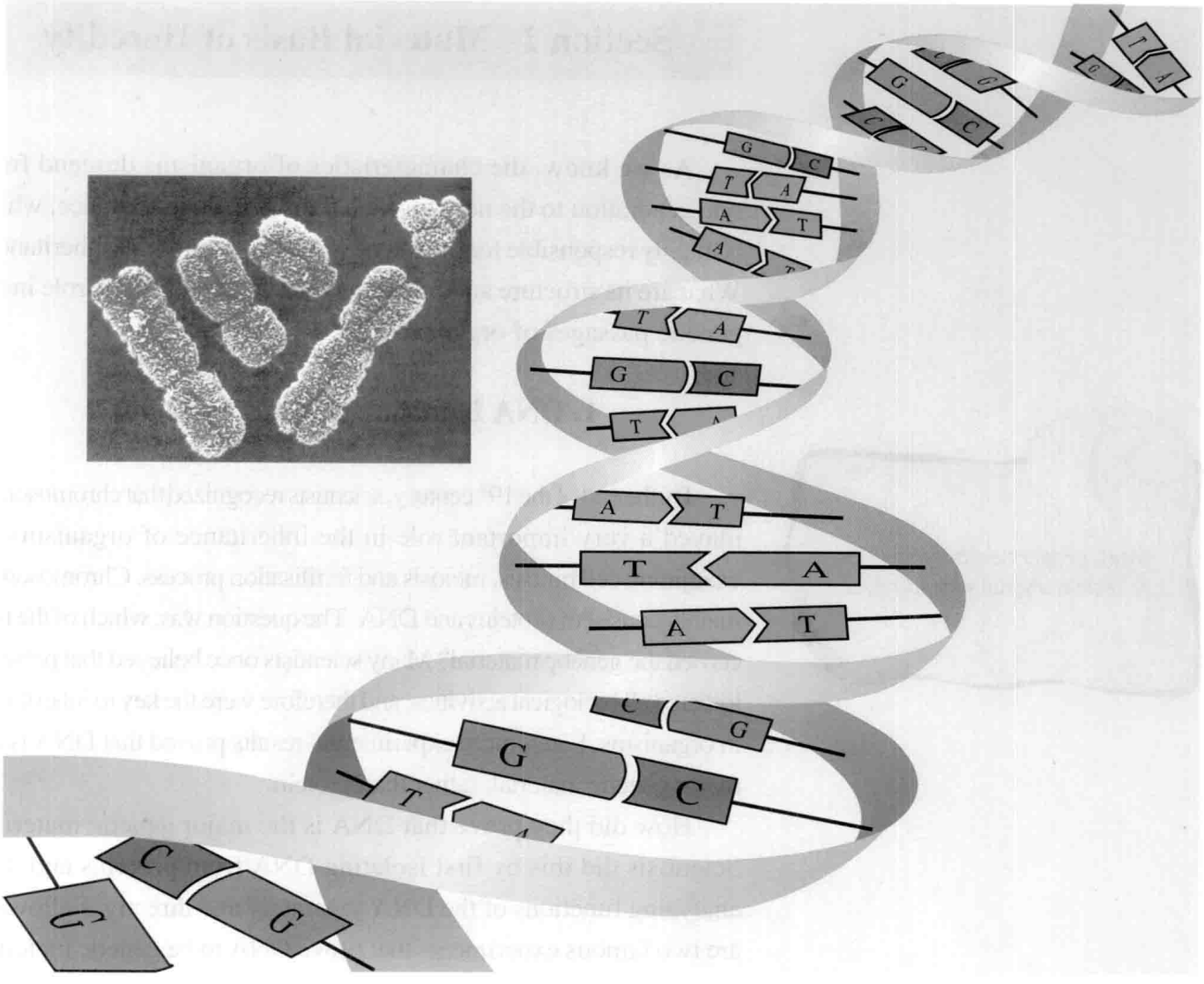


The discovery of the DNA double helix marked the birth of molecular biology

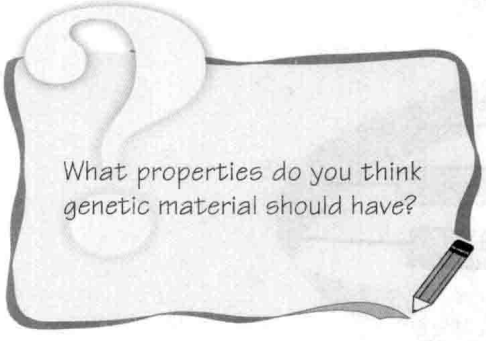
Chapter 6 Heredity and Variation

We know that all organisms can demonstrate heredity and variation. But, we still need to find out: how do heredity and variation occur? What part of the organism is mainly responsible for this? And what are the fundamental regulations for heredity and variation? In the last hundred years or so, scientific research has examined this question, and great progress has been made. In the 1960s, the geneticist Gregor Mendel (1822-1884) revealed two basic genetic laws by studying beans. In the mid-20th-century, scientists have been able to study genetics at the molecular level. Now, as biological technology has developed, many important industrial and biological questions having a direct bearing on human beings have been studied or resolved by using genetic recombinations at the molecular level.

Section 1 Material Basis of Heredity

As we know, the characteristics of organisms descend from one generation to the next through their genetic inheritance, which is mainly responsible for heredity. Now then, what is this inheritance? What are its structure and functions? How does it play its role in the genetic passages of organisms?

1. DNA is major genetic material



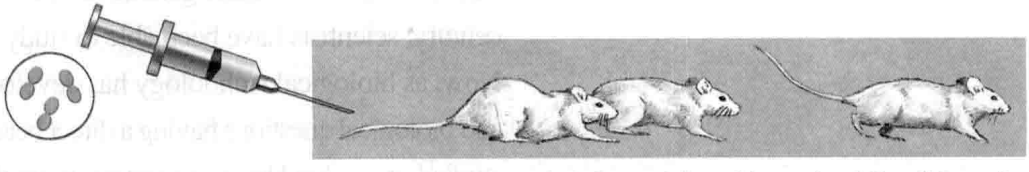
By the end of the 19th century, scientists recognized that chromosomes played a very important role in the inheritance of organisms by examining cell mitosis, meiosis and fertilisation process. Chromosomes mainly consist of proteins and DNA. The question was, which of the two carried the genetic material? Many scientists once believed that proteins initiated all biological activities, and therefore were the key to inheritance in organisms. Later, more experimental results proved that DNA is the major genetic material, rather than protein.

How did they prove that DNA is the major genetic material? Scientists did this by first isolating DNA from proteins and then analyzing functions of the DNA separately and directly. Following are two famous experiments that prove DNA to be genetic material.

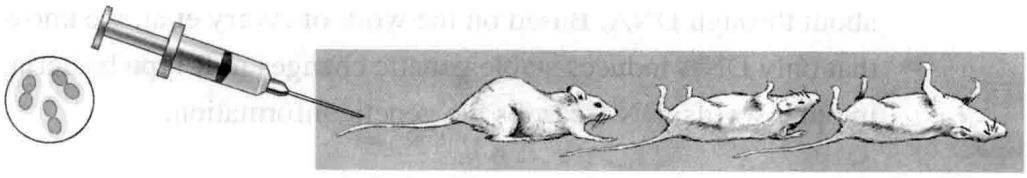
Transformation experiments of streptococcus pneumoniae

In 1928, the English scientist Frederic Griffith (1877-1941) carried out experiments on mice using the bacterium streptococcus pneumoniae. In his experiments two different strains of this bacteria was used. One strain was called the R type, which has a rough appearance without capsular polysaccharide, and is avirulent. The other strain was called the S type and has a smooth appearance and capsular polysaccharide, and was virulent.

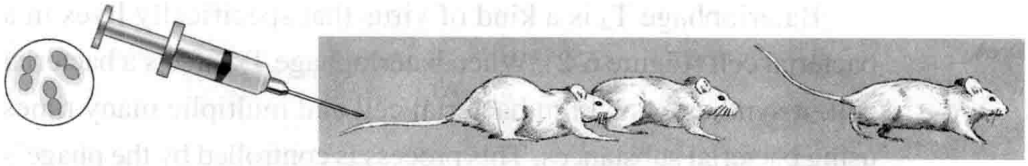
The transformation experiment of streptococcus pneumoniae was carried out in four groups as follows (Figure 6-1):



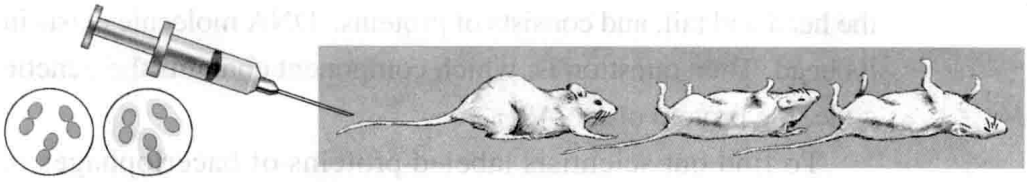
(1) The live bacteria of the R type (not lethal) was injected into mice. Mice did not die.



(2) The live bacteria of the S type (lethal) was injected into mice. Mice died from hemolysis.



(3) The heat-killed bacteria of the S type were injected into mice. Mice did not die.



(4) Finally a mixture of the live benign R type and the heat-killed S type was injected into mice, and the mice died from hemolysis.

Figure 6-1 Transformation experiment of streptococcus pneumoniae

From the dead mice of group 4, the virulent live bacteria of the S type were isolated by Griffith, showing that benign R type bacteria were changed to virulent S type bacteria after being mixed with heat-killed S type bacteria. In addition, Griffith found that the offspring of the changed S type also had virulent S type bacteria. So it proved that a transformed characteristic could be inherited.

Why was the benign bacteria type transformed into the virulent S type? Griffith speculated that the heat-killed S type bacteria in group 4 must contain a substance which could initiate the inheritance of characteristics 'transforming principle at that time'. However, Griffith did not know what the transforming principle was.

In order to clarify inheritance in nature, the American scientist, Oswald Avery(1877-1955), and his colleagues in 1944 separated three classes of molecules, i.e., DNA, proteins and polysaccharide from live bacteria of the S type, and then R type bacteria individually. He found that only the R type bacteria in the group containing foreign DNA were changed into S type, and the purer the DNA, the more effective the change. Avery also found that the changes to the R type bacteria could not happen if the DNA taken from the S type bacteria was treated with DNase, indicating that the changes come

about through DNA. Based on the work of Avery et al, we know that only DNA induces stable genetic changes in R type bacteria, in other words, DNA carries the genetic information.

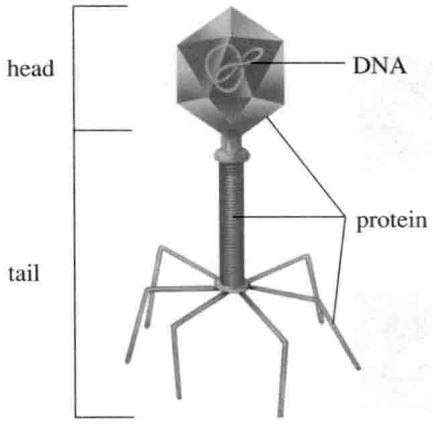


Figure 6-2 Model of bacteriophage

Infection of bacteria by phage

Bateriophage T_2 is a kind of virus that specifically lives in a bacterial cell (Figure 6-2). When bateriophage T_2 infects a bacterial cell, it synthesizes within bacterial cell and multiplic many times using bacterial substances. This process is controlled by the phage's own genetic code. Bacteriophage T_2 coat encloses (or packages) the head and tail, and consists of proteins. DNA molecule exists in its head. Then question is: which component contains the genetic code, the protein or DNA?

To find out scientists labeled proteins of baceriophages in one test group, with radioactive isotope ^{35}S and labeled DNA in the other with radioactive isotope ^{32}P. The two groups of labeled bacteriophages were then used to infect different bacteria (Figure 6-3). After the bacteriophages had propagated rapidly, labeled compounds were tested. The results showed that labeled proteins of bacteriophges did not enter bacterial cells, but were left outside instead. But, DNA did enter bacterial cells. Therefore, propagation

What is the reason for choosing ^{35}S and ^{32}P as radioisotopes to label protein and DNA? Can we use ^{14}C and ^{18}O for the same purpose?

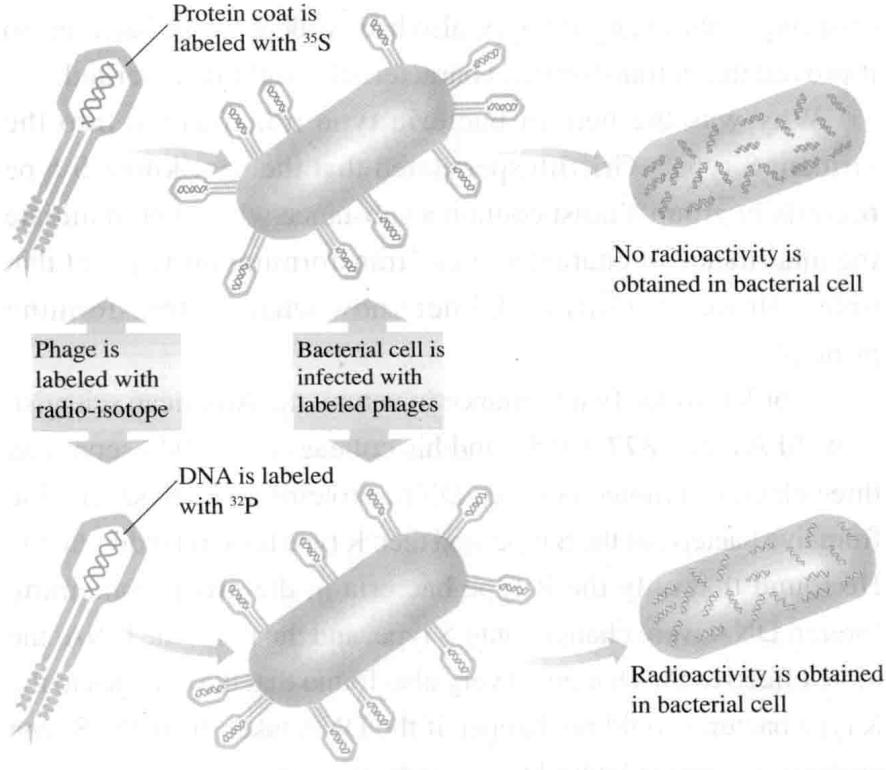


Figure 6-3 Infection of bacteria with phage T_2

of phage in bacterial cell is controlled by the phage's own DNA.

These experimental results showed that the substance keeping continuity of parent and progeny in phage is DNA, rather than protein. In other words, phage characteristics in its progeny are transmitted from its parents through DNA. So DNA carries the real genetic code.

Modern scientific research demonstrates that RNA is another kind of genetic material in addition to DNA. Some viruses contain protein and RNA with no DNA, for example TMV (tobacco mosaic virus). Proteins extracted from TMV can not infect tobacco, but RNA extracted from TMV can. Therefore, RNA carries the genetic code in these viruses. Since DNA carries genetic code in most organisms, we may say DNA is main or major genetic material.

Content link

In the chemical composition of bacteriophage T_2, 60% is protein, 40% is DNA. Further analysis of protein and DNA shows that S (sulphur) is present only in protein molecules and 99% of P (phosphorous) is in DNA molecules.

[Experiment 11] DNA extraction and identification

Experimental principles

The solubility of DNA in saline varies with the concentration of NaCl solution. When the concentration of sodium chloride is 0.14 mol / L, the DNA solubility is at its lowest. Based on this principle, we can extract DNA from a NaCl solution.

DNA does not dissolve in ethanol, but some substances in the cell do. We can use this method to purify DNA.

As DNA becomes blue in boiling water bath when benzedine is added, benzedine can be used as a specific reagent to identify DNA.

Purposes and requirements

To grasp the methods for crude extraction and identification of DNA, and observe the appearance of extracted DNA preparation primarily.

Materials and appliances

Chicken blood cells (5-10ml).

Iron or steel stand and rings, tweezers, tripod, alcohol burner, asbestos meshes, slides, glass rod, filter paper, pipettes, cylinders (1 of 100ml), beakers (1 of 100ml, 2 of 50mml and 500ml, each), test tube (2 of 20ml), funnel, tube clips, and gauze.

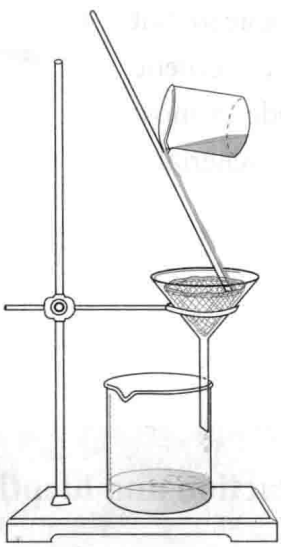
95% ethanol (V/V) (placed in refrigerator for 24 hours before use), distilled water, 0.1g/ml of sodium citrate, 2mol/l and 0.015mol/l of sodium chloride, and benzidine reagent.

Methods and steps

To prepare fresh chicken blood cell suspension (by teacher): ① In a 500ml beaker, add 100ml of 0.1g/ml sodium citrate (an anticoagulant) and then about 180ml of fresh killed-chicken blood. ②Stir the mixture with a glass rod until blood and sodium citrate mix enough to prevent coagulation. ③Transfer the blood mix into a centrifuge tube. Spin at 1000

rpm for 2min. Blood cell pellets now precipitate onto bottom of centrifuge tube. ④ Remove the supernatant with a pipette. Now chicken blood cell solution is ready. (If a centrifuge is not available, place the beaker containing the blood mix in a refrigerator overnight, allowing the blood cells to precipitate well.)

1. Extract nuclear substance from chicken blood cells



Add 5-10ml of well-prepared chicken blood solution into a 50ml beaker. Then add 20ml of distilled water into the beaker and stir with a glass rod at a higher speed in same direction for 5minutes in order to speed up cell breakage. Filtrate it with layers of gauze through a funnel into a 500ml beaker. Keep the filtrate for use.

2. Dissolve nuclear DNA

Add 40ml of 2mol/L sodium chloride to the filtrate. Stir with a glass rod in the same direction for 1 minute in order to mix well. DNA in the solution is now dissolved.

3. Precipitate the viscous substances in which DNA is contained

Pour the distilled water into the beaker against the inner wall very slowly and at the same time stir with a glass rod in the same direction very gently. After a short time, a viscous fibre appears in the beaker. Now observe the color of the viscous fibre carefully. Add more distilled water, and the viscous fibre will increase. If no more water is added when the amount of the viscous fibre stops increasing (concentration of sodium chloride in solution is about 0.14mol/l at the time).

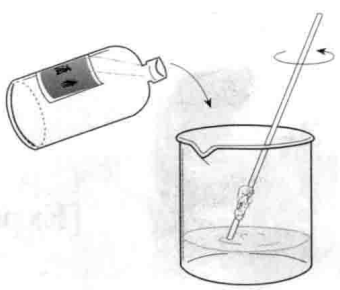
4. Filtrate DNA-containing viscous substance

Filtrate the liquid obtained in step 3 into a 500ml beaker by using layers of gauze in a funnel. Discard the filtrate, and keep the viscous fibres on the gauze for use in the next step.

5. Redissolve the viscous fibroid DNA

Pour 20ml of 2mol/l sodium chloride into a 20ml beaker. Transfer the gauze containing the viscous DNA into a NaCl solution with blunt tweezers. Stir in the same direction for 3 minutes to make the viscous substance dissolve as much as possible.

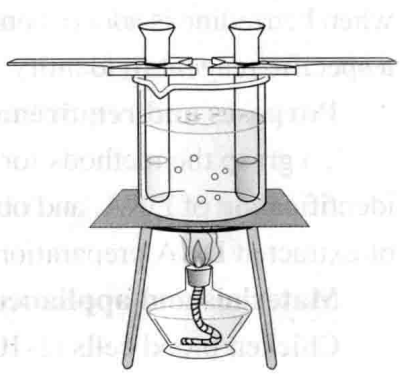
6. Filtrate NaCl solution of DNA



Filtrate the liquid obtained in step 5 into a 100ml beaker with two layers of gauze in a funnel. Keep filtrate that contains DNA.

7. Make DNA preps with fewer impurities

Pour 50ml of pre-cooled 95% (V/V) ethanol into the filtrate obtained in step 6 very slowly (the reason for using pre-cooled ethanol is for better precipitation of DNA), and stir in the same direction very gently. Silky pellets with fewer impurities will appear. Pick up the pellets with a glass rod, press it against the beaker wall to get rid of the water or suck up the water with a sheet of sterile filter paper. The major component of the pellets is DNA. Observe the color of the silky pellets.



8. Identify DNA preparations

Add 5ml of 0.015mol/L sodium chloride each to two 20ml-test tubes.

Transfer the silky pellets into one of the tubes, stir with a glass rod to dissolve the pellets. Then, add 4ml of benzidine reagent to each tube, mix thoroughly, and heat the tubes in boiling water for 4 minutes. Observe and compare the change of color in the two tubes when they cool.

Conclusions

Write down the phenomena observed and conclusions and fill them in your laboratory notebook.

Discussions

1. Why does the blood supernatant have to be removed when you want to extract DNA from chicken blood?

2. In step1 and step3, it is necessary to add water. The role water plays is the same in the two steps? Why?

3. The diameter of the DNA molecule is about 2nm. Does the diameter of the fibre in the experiment represent the diameter of a DNA molecule or not?

Review

1. Fill in the following blanks

(1) The well-established experiments for demonstrating that DNA is the genetic material are _____ _____ and _____ _____.

(2) During 1940s to 1960s, scientists showed that DNA carries the genetic code through various experiments. In all these experiments, scientists tried to separate _____ and _____, in order to reveal the function of DNA _____.

2. Mark the following statements (+ correct, − incorrect)

(1) All species of DNA in cells are the component of chromosomes ( )

(2) All genetic material in eukaryotic cells is DNA, and that in a virus is RNA ( )

3. Give a short answer

In the experiment transformating the bacterium streptococcus pneumoniae, which is the experiment design that demonstrates that DNA has the genetic code? What must one do to implement this design? What connections are there between science and technology?

2. Structure and replication of the DNA molecule

We already know that DNA carries the genetic code, by which biological characters pass from parents to children. Now, we ask how DNA is able to play its hereditary role. It is very closely related to the properties of its structure and function.

The structure of DNA molecule

By 1940s and 1950s, scientists already knew that DNA is a kind of macromolecular compound, consisting of four deoxyribonucliosides. However, it was still a mystery how the DNA