

# CHANCE FAVORS ONLY THE PREPARED MIND— THE DISCOVERY OF PENICILLIN

- **ALTHOUGH THE FIRST ANTIBIOTIC, PENICILLIN, WAS KNOWN IN 1896, THE SUBSTANCE WAS NOT FULLY INVESTIGATED. HOWEVER, IN 1928 A SMALL INCIDENT AROUSED DR. ALEXANDER FLEMING'S INTEREST IN INVESTIGATING THE NATURE OF PENICILLIN, WHICH LED TO A LANDMARK DISCOVERY IN MEDICINE AND SAVED MILLIONS OF LIVES. THIS LESSON INTRODUCES THE STORY OF THE DISCOVERY OF PENICILLIN.**

In addition you will learn:

- how to become a critical reader
- how to use logical connectors to link clauses in writing
- how to cite references in reporting a study
- what a hedge statement is and why scientists use hedges in reporting their findings
- more information about the history and use of penicillin in medical treatment

## Before You Read

Penicillin is an antibiotic used to kill bacteria and cure infection. It has been used widely since the 1940s, and was once seen as a miracle cure. However, one serious problem is the misuse and overuse of such medicines, which can lead to the problem of antibiotic resistant bacteria.

*Discuss the following questions in small groups.*

1. Have you ever been treated with an antibiotic? Why was an antibiotic used? What would have happened if an antibiotic had not been prescribed?
2. What are some reasons for the misuse and overuse of antibiotics in Taiwan?
3. Although penicillin has saved many lives, does the wide use of this substance possibly have any

negative effects?

*Reading Skills, Critical reading—please carefully read the following explanation.*

Reading a text critically means you make judgments about it as you read. That is, you do not accept everything you are reading, but ask questions. For example,

How does the text work?

How is it argued?

Is the argument logical?

How does the text reach conclusions?

When you question the text (searching for answers) as you read, you are activating critical thinking skills and thus acquiring in-depth reading skills.

There are some steps for critical reading: interpretation, analysis, synthesis and evaluation. A reader first interprets the meaning of the text and then analyzes the interpretation. Within the analysis process, you need to:

- identify the assumptions of the text
- recognize the structure of the argument
- build up the relationship between evidence/data and the argument

**Answering the following questions will help the reader to judge whether the text has achieved its goal.**

1. What are the central claims of the text?
2. Who are the target readers?
3. Is the background information sufficient and comprehensible to the target readers?
4. How does the author argue for the claims?
5. Is the argument supported with sufficient evidence?
6. Can the evidence be interpreted differently?
7. What are the strengths and weaknesses of the argument?
8. Are the conclusions warranted by the evidence presented?

Reading is actually an interactive process between the reader and the text (and consequently, the author).

**Exercise**

Now, read the following passage. Answer the questions applying your critical knowledge about the reading.

**Antibiotics abuse**

Antibiotics have been considered a “wonder medicine” in infection treatment. They are used widely nowadays. However, a serious situation related to the use of antibiotics is spreading around the world. In China, antibiotics abuse is considered a serious problem. The data shows that adverse side-effects of drugs caused 192,000 deaths in China in 2008, and about two thirds of these were due to bacterial resistance to antibiotics. (Paragraph 1)

Penicillin, discovered in 1928 by Alexander Fleming, has been used for decades to treat many potentially life-threatening bacterial infections. However, misuse of this miracle drug is now leading to the return of infectious diseases for which there is no effective treatment. “Penicillin used to be effective in treating any infection, but nowadays over 80 per cent of staphylococci are resistant to the drug; and about 33 per cent of *Pseudomonas aeruginosa* are resistant to gentamicin,” said Professor Jiang Jian, vice-director of Shuguang Hospital. (Paragraph 2)

The problem of drug-resistant bacteria is even worse in children. In one case, doctors were shocked to find that the bacterial strain isolated from a 10-year-old girl suffering from a urinary tract infection was resistant to 12 kinds of antibiotics. According to a report from the World Health Organization (WHO), almost all major infectious diseases are slowly but surely becoming resistant to existing drugs. To date, more than 200 types of antibiotics have been developed. However, humans are now in a race against time to bring levels of infectious disease down worldwide before the diseases are able to overwhelm the drugs developed to fight them. (Paragraph 3)

1. \_\_\_\_\_ What is the main function of the text?
  - A. To explain the uses of antibiotics
  - B. To show the benefits of using antibiotics.
  - C. To explain the problems with using antibiotics.
2. \_\_\_\_\_ Which paragraph establishes a critical statement about using antibiotics?
  - A. Paragraph 1

- B. Paragraph 2  
C. Paragraph 3
3. \_\_\_\_\_ Which paragraph provides background knowledge about overuse of penicillin?  
A. Paragraph 1  
B. Paragraph 2  
C. Paragraph 3
4. Can you list some evidence which can strongly support the author's claim?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_ How do you evaluate the evidence used by the author?  
A. Strong  
B. Weak  
C. Unknown

## Reading

### Chance Favors Only the Prepared Mind

“In the field of observation, chance favors only the prepared mind,” said Louis Pasteur (1822-1895) in his lecture at University of Lille, France in 1854. Louis Pasteur was a French chemist known for creating the first vaccine for **rabies** and developed a process of treating milk and wine that was later called pasteurization. Pasteur meant that in the field of observation, only those with prepared minds can come up with new ideas. “Occasional phenomenon” provides opportunities for scientific discoveries. Nevertheless, it is up to the individual researcher's sensitivity and ability to discover and verify new theories.

- 5
- 10 In the summer of 1928, Dr. Alexander Fleming was investigating the properties of staphylococci before he left for a vacation. Normally, he would have grown the bacteria in a Petri dish for 24 hours under 37°C incubation. As he would be going away for a while, he decided to put the Petri dish on top of a bench. Upon returning from his trip, he found that

the Petri dish was contaminated by molds. He noticed an interesting phenomenon—there were no bacterial colonies grown in the zones around the invading molds. It occurred to him that this mold might inhibit the growth of bacteria, so he tested the phenomenon again and

**15** reached the same conclusion as in the previous experiment. Dr. Fleming named this new type of mold *Penicillium notatum*.

Dr. Fleming's results were published in the "British Journal of Experimental Pathology" in 1929. However, he had a hard time purifying the substance from the mold due to its unstable characteristics, and gave up in the end. Fortunately, Dr. Howard Walter Florey and

**20** Dr. Ernst Boris Chain, after reading Fleming's paper, picked up this project. After much trial and error, they discovered the method for efficient extraction of the active ingredients of the mold, and were able to undertake large-scale production. This substance was later called Penicillin., and in 1945 the three scientists received the Nobel Prize in Medicine for their work. Since then, this discovery has saved more than 200 million lives.

**25** Other researchers would have discarded the contaminated Petri dish immediately. In fact, in 1896, a French medical student injected streptococcus into animals and found that if he injected the bacteria together with this kind of mold, the death rate of the animals decreased significantly. Unfortunately, he didn't carry his observation further. It was likely that he had no idea about the possible relationship between antibiotics and bacteria. So, what made Dr.

**30** Fleming study the mold in his contaminated plate? Perhaps he was in a good mood and had a refreshed mind when he returned from his vacation. It might also be that he had been studying the effects of lysozyme in inhibiting the growth of bacteria during that period, so he had a rough idea in his mind. The refreshed mind and an idea to connect to might have led him to investigating this "occasional phenomenon." Preparedness paved his way to the

**35** discovery of the world's first antibiotic.

Some of the greatest achievements in the field of medicine and science seem to sprout from accidental discoveries. However, if the scientists did not have a prepared mind with necessary knowledge and ability, they would not be able to grasp the critical information in front of them. Therefore, those who dedicate themselves to scientific research should

**40** maintain a lifestyle with a high level of creative thinking and curiosity to be able to sense an opportunity, and take every chance to accumulate the skills and knowledge necessary to seize it.

## After You Read

**I** *Reading Comprehension Check*—match the names with the events by filling in the blanks.

*Note: Two questions have more than one answer.*

- A. Dr. Fleming
- B. A French medical student
- C. Dr. Howard Walter Florey
- D. Dr. Ernst Boris Chain

1. Penicillin was first discovered in 1896 by \_\_\_\_\_.
2. *Penicillium notatum* was named by \_\_\_\_\_.
3. \_\_\_\_\_ had difficulty in purifying the antibiotic from the mold.
4. \_\_\_\_\_ found a method to extract the active ingredients of the mold.
5. \_\_\_\_\_ had already had the idea that a certain agent could inhibit bacterial growth.
6. \_\_\_\_\_ won the Nobel Prize for Medicine in 1945.

**II** *Paraphrasing*—use the following steps to write one sentence summarizing the main point of each paragraph.

Step 1: Read the paragraph carefully and decide which information is important. Underline these important concepts.

Step 2: Write one sentence that includes all of the important concepts.

Step 3: Try to shorten that sentence. Use the fewest words possible to describe the main points of the paragraph.

	Paraphrase
Paragraph 1	Scientific discoveries depend on the scientist being ready and able to follow up on interesting observations.
Paragraph 2	
Paragraph 3	
Paragraph 4	
Paragraph 5	

## Vocabulary Comprehension

### ESP Vocabulary

*This vocabulary is commonly used in the field of bio- and medical science.*

staphylococci	<i>n</i>	spherical gram-positive parasitic bacteria that usually form irregular colonies
incubation	<i>n</i>	the development and growth of bacteria
Petri dish	<i>n</i>	a shallow dish used to culture bacteria
streptococcus	<i>n</i>	spherical gram-positive bacteria appearing in pairs or chains
lysozyme	<i>n</i>	an enzyme found in saliva, sweat and tears which can destroy the cell walls of certain bacteria

### General Vocabulary

*This vocabulary is used for general purposes.*

contaminate	<i>v</i>	to make something dirty, polluted or poisonous
mold	<i>n</i>	green or white microorganisms that grow on stale food or dead tissue
inhibit	<i>v</i>	deter, stop or slow something from happening
discard	<i>v</i>	to get rid of something or someone
ingredient	<i>n</i>	the individual parts in a mixture
substance	<i>n</i>	a material

### Exercise

*Please write one synonym for each of the following words, taking vocabulary from the two boxes, above. If necessary, make small changes:*

Ex. collected = gathered

throw away = \_\_\_\_\_ material = \_\_\_\_\_

kill off = \_\_\_\_\_ constituent = \_\_\_\_\_

polluted = \_\_\_\_\_

### Phrases

Here are some phrases used in the article that are useful in speaking and/or writing. Work in pairs to discuss the meaning of these phrases, based on the example sentences.

#### come up with

Only those with prepared minds can **come up with** new ideas. (Paragraph 1)

#### purify...from

He had a hard time **purifying** the substance **from** the mold due to its unstable characteristics. (Paragraph 2)

#### sprout from

Some of the greatest achievements in the field of medicine and science seemed to **sprout from** accidental discoveries. (Paragraph 4)

#### dedicate to

Those who **dedicate** themselves **to** scientific research should maintain a lifestyle with a high level of creative thinking and curiosity to be able to sense an opportunity. (Paragraph 4)

### Exercise

Please work together and make complete sentences using the phrases, above.

1. come up with

2. purify...from

3. sprout from

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4. dedicate to

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## Language Focus

### Logical connectors

Logical connectors are used to join or connect two ideas that have a particular relationship. These relationships can be: sequential (time), causal (reason and purpose), adversative (opposition and/or unexpected result), and conditional. In English, prepositions, conjunctions, and transitions (or linking words) can be used as logical connectors to indicate these relations between clauses.

### Sequential connectors

Sequential connectors mark the time relationship between two clauses.

For example,

In the summer of 1928, Dr. Alexander Fleming was investigating the property of staphylococci **before** he left for a vacation.

Some common sequential connectors include:

until, after, before, when, while, since, once, whenever, as soon as, as long as, by the time, during, after, until, upon, then, next, after that, following that, before that, afterwards, meanwhile, beforehand

### Causal connectors

Causal connectors are used to indicate reasons, results, or a cause-effect relationship between the clauses.

For example,

It might also be that he had been studying the effects of lysozyme in inhibiting the growth of bacteria during that period, **so** he had a rough idea in his mind.

Some common causal connectors include:

because, as, since, inasmuch as, now that, as long as, such...that, so...that, in order that, because of, due to, in order to, therefore, consequently, so

### **Additive and adversative connectors**

Additive connectors are used to add information to the existing statement.

For example,

It has been used widely since the 1940s **and** was once seen as a miracle cure.

Some frequently used additive connectors include:

and, in addition, furthermore, moreover

Adversative connectors mark an opposite or contrastive idea from the existing statement. Some adversative connectors also indicate an unexpected idea.

**Nevertheless**, it is up to the individual researcher's sensitivity and ability to discover and verify new theories.

**However**, he had a hard time purifying the substance from the mold due to its unstable characteristics, and gave up on this project.

Some frequently used adversative connectors include:

but, even though, although, though, in spite of the fact that, while, whereas, where, despite, in spite of, however, nonetheless, nevertheless, on the other hand, in contrast, on the contrary, but...anyway, but...still, yet...still

### **Conditional connectors**

Conditional connectors indicate a condition stated by the subordinate clause, and the main clause usually states the result of the condition.

For example,

**However**, if the scientists did not have a prepared mind with necessary knowledge and ability, they would not be able to grasp the critical information in front of them.

Some frequently used conditional connectors include:

If, unless, even if, providing (that), provided (that), in case, whether or not, otherwise, or (else)

**Exercise**

*Read the following passage and mark all the logical connectors. Based on the terms introduced, above, replace these connectors with different ones without altering the meaning of the sentences. Sometimes you may need to significantly alter the grammar when a new term is used.*

Bacteria are living organisms existing as single cells. Bacteria are everywhere and most don't cause any harm. In some cases, bacteria may be beneficial. Lactobacillus, for example, lives in the intestine and helps digest food. But some bacteria are harmful and can cause illness by invading the human body, multiplying, and interfering with normal bodily processes. Antibiotics are effective against bacteria because they work to kill these living organisms by stopping their growth and reproduction.

Viruses, on the other hand, are not alive and cannot exist on their own — they are particles containing genetic material wrapped in a protein coat. Viruses “live,” grow, and reproduce only after they have invaded other living cells. Some viruses may be fought off by the body's immune system before they cause illness, but others (colds, for example) must simply run their course. Most importantly, viruses do not respond to antibiotics at all. Therefore, antibiotics do not cure diseases caused by viruses. Moreover, the misuse and overuse of antibiotics leads to antibiotic resistant bacteria.

Your sentences:

1. Bacteria are everywhere and most don't cause any harm.

→ Bacteria are everywhere. Furthermore, most don't cause any harm.

2. \_\_\_\_\_

\_\_\_\_\_

3. \_\_\_\_\_

\_\_\_\_\_

4. \_\_\_\_\_

\_\_\_\_\_

5. \_\_\_\_\_  
\_\_\_\_\_

6. \_\_\_\_\_  
\_\_\_\_\_

## Tasks

### Speaking: Hedging

A hedge is a way of expressing an idea to lessen the impact, and typically they use adjectives, adverbs, or modal verbs, but can also utilize clauses.

For example,

1. He is only slightly overweight. (adverb)
2. There might just be a few insignificant problems we need to address. (adjective)
3. The results could be improved if more accurate instruments were used. (modal verb)
4. I'm not a car mechanic but you might want to check if your tank is empty. (clause)

When reporting scientific findings, it is sometimes useful to use hedges for indicating uncertainty. For example, Dr. Fleming first found the mold and predicted that the mold inhibited the growth of bacteria. Before his experiment, he might have said:

“I found mold in the Petri dish which might inhibit the growth of bacteria.”

Because it was a hypothesis rather than a fact, it was appropriate to hedge the statement. In addition, avoiding the use of first person pronouns when presenting findings—such as *I* and *we*—can redirect doubts to a third party. In this way, the speaker reduces his/her own authority with regard to the subject matter.

Compare these two sentences:

- a. The culture showed that mold could inhibit the growth of bacteria.
- b. I think that mold could inhibit the growth of bacteria.

Sentence a. seems more objective, and it makes the audience believe the statement is based on the results from the culture rather than the researcher's opinion.

### Exercise

*Here is an excerpt from a speech Dr. Fleming gave in 1945. Read the passage and mark the hedges. With a partner discuss the purposes of these usages.*

Then in 1928 an accidental contamination of a culture plate by a mold set me off on another track. I was working on a subject having no relation to molds or antiseptics, and if I had been a member of a team engaged on this subject it is likely that I would have had to neglect the accidental happening and work for the team with the result that penicillin would not then have been described and I would not be here today as a Nobel Laureate. But, fortunately for myself - and maybe for the world - I was situated so that I could leave my previous line of research work and follow the track which fate had indicated for me.

### Writing: How to Write a Lab Report (3)

The last section of a lab report is the list of citations, which is a list of published and unpublished sources, i.e., all the articles or books cited in your report. The primary purpose for giving a citation is intellectual honesty. After all, all scientific findings are inspired or based on previous works in the field, and these need to be acknowledged. Moreover, a list of references can be useful for readers who wish to learn more about a particular detail of your work.

There are different styles for citing academic works. The following examples use the format specified by American Psychological Association (APA). This is also the most commonly used format in the field of bio-medical science:

For articles:

Fleming A. (1929). On the antibacterial action of cultures of a *Penicillium*, with special reference to their use in the isolation of *B. influenza*. *Br J Exp Pathol.* 10 (31): 226–36

Grossman, Charles M. (2008). The first use of penicillin in the United States. *Ann Intern Med,* 149:135-136.

For Books:

Bird, W.Z. 1990. Ecological Aspects of Fox Reproduction. Berlin: Guttenberg Press.

For chapters in books:

Smith, C.J. 1989. Basal cell carcinomas. In *Histological Aspects of Cancer*, ed. C.D. Wilfred, pp. 278-91. Boston: Medical Press.

For on-line sources:

Danger of antibiotic overuse. (n.d.). Retrieved January 14, 2010, from [http://kidshealth.org/parent/h1n1\\_center/h1n1\\_center\\_treatment/antibiotic\\_overuse.html](http://kidshealth.org/parent/h1n1_center/h1n1_center_treatment/antibiotic_overuse.html)

### Exercise

1. *Work in pairs. Pull out some text books from your bags and examine the copyright pages. Note the title, author(s), publisher, and the publication date and place.*
2. *Write two citation entries, one citing the entire book and one citing one chapter of the book.*

### Further Reading: The History of Penicillin

#### Website of the Day

<http://inventors.about.com/od/pstartinventions/a/Penicillin.htm>

<http://www.cellsalive.com/pen.htm>

#### Extra Info:

Penicillin was initially noticed by a French medical student, Ernest Duchesne, in 1896; however, the information was not widely known at that time. In 1928, penicillin was re-discovered by Alexander Fleming who worked at St. Mary's Hospital in London. He found a blue-green mold in a plate culture of staphylococcus which dissolved colonies of bacteria adjacent to the mold. Then, Alexander Fleming grew the mold in a pure culture and discovered that it produced this particular substance, which was able to kill a great number of disease-causing bacteria. Dr. Fleming then published the results of his studies in 1929.

However, Dr. Fleming's discovery did not raise a great deal of interest in using penicillin for medical treatment until the 1940s. Howard Florey and Ernst Chain then carried out intensive research and conclusively demonstrated that penicillin could kill infectious bacteria. They also isolated the active ingredient and developed a powdery form of the medicine. However,

penicillin was not manufactured in large quantities in the early 1940s, so the price for one dose remained high. However, Andrew Moyer and Dr. Heatley found a way to mass produce penicillin, and then it quickly moved through more clinical trials and was recognized as the most effective antibacterial agent. Moreover, due to increased production, the price of one dose decreased from \$20 to \$0.55.

Although penicillin is an effective medication for killing disease-causing bacteria, it is always recommended that patients have a skin test for penicillin allergy before taking the drug. If a red, raised wheal larger than 5 millimeters appears on the skin of the patient, penicillin should not be prescribed.



### End-of-Lesson Quiz

*Below is a summary of the main article in this lesson; however, there are six mistakes in the passage. Find the mistakes and correct them.*

Penicillin was first found by Dr. Alexander Fleming in 1928. He was planning to grow the bacteria in a china dish for 24 hours under 40°C incubation. However, he placed the dish on a bench for only a few hours, and on returning found streptococcus in the culture. The interesting thing was no other bacteria existed in the culture, except for streptococcus. He thus believed that it was able to inhibit the growth of bacteria, and was later able to successfully extract the substance because of its stable feature. In the 1940s, Dr. Florey and Chain made a large-scale reproduction and used this substance in clinical trails to cure infection.

Mistake 1: \_\_\_\_\_

Mistake 2: \_\_\_\_\_

Mistake 3: \_\_\_\_\_

Mistake 4: \_\_\_\_\_

Mistake 5: \_\_\_\_\_

Mistake 6: \_\_\_\_\_