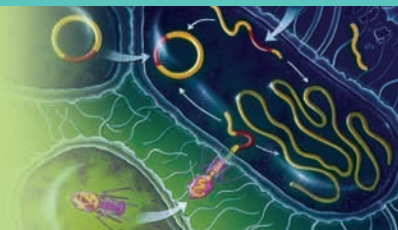


1 Applications of Micro-organisms



1.1 Micro-organisms

Recall what you have learnt about micro-organisms in grade 8. You have learnt micro-organisms are unicellular or multicellular organisms which can not be seen clearly with the naked eye. Do assignment 1.1 using the previous knowledge.



Assignment 1.1

- Prepare a list of the groups of micro-organisms you know and write names of micro-organisms belong to each group.

Micro-organisms live in our environment as well as in our body.

Most micro-organisms are favourable to humans and other living beings, but some are harmful.

Micro-organisms are very wide spread and common species category of living organisms on Earth. They are a group of living organisms with a simple structure. They grow fast and have high rate of reproduction.

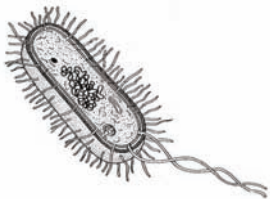

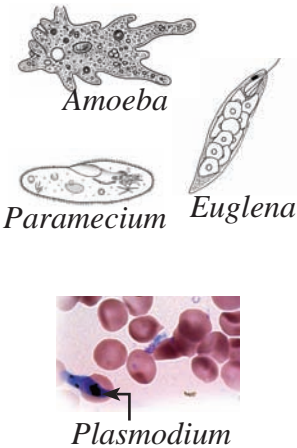
Micro-organisms have the ability to adapt for different environmental conditions and modes of nutrition.



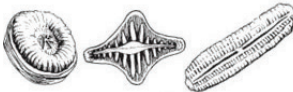


Unicellular and some of the multicellular organisms can be seen in micro-organism category.

These micro-organisms can be categorized into groups as bacteria, fungi, algae and protozoa. Viruses which are a group in between the living and non-living are also studied under micro-organisms.

Let us study table 1.1 to know about the category of micro-organisms.

Table 1.1 - Characteristics of different micro-organism categories and examples for them

Category of micro-organisms	Characteristics	Examples
<p>Bacteria</p> 	<ul style="list-style-type: none"> • Unicellular and microscopic • Different body shapes • Widely spread in every type of environment on Earth 	<ul style="list-style-type: none"> • Milk and products related to milk - <i>Lactobacillus bulgaricus</i> • Anthrax disease - <i>Bacillus anthracis</i> • Bacteria used in Vineger production - <i>Acetobacter aceti</i> • Cholera diseases - <i>Vibrio cholerae</i>
<p>Fungi</p> 	<ul style="list-style-type: none"> • Unicellular or multicellular • Reproductive organs of some fungi can be seen with naked eye e.g. mushroom • Thrive on moist surface (substrate) 	<ul style="list-style-type: none"> • Fungi on bread - <i>Mucor</i> • Yeast - <i>Saccharomyces</i>
<p>Protozoa</p> 	<ul style="list-style-type: none"> • Unicellular and microscopic • Use structures such as cilia, pseudopodia and flagella for locomotion • Live in aquatic environments as well as in other living organisms 	<ul style="list-style-type: none"> • <i>Amoeba</i> • <i>Paramecium</i> • <i>Euglena</i> • <i>Plasmodium</i>

<p>Algae</p>  <p><i>Chlamydomonas</i></p>  <p><i>Spirogyra</i></p>  <p><i>Diatoms</i></p>	<ul style="list-style-type: none"> • Unicellular or multicellular • Filamentous or thallus body forms • Microscopic algal floating on water surface are called phytoplanktons • Possess chlorophyll and have the ability of photosynthesis • Algal variety such as ulva visible to the naked eye 	<ul style="list-style-type: none"> • <i>Chlamydomonas</i> • <i>Spirogyra</i> • <i>Diatoms</i>
<p>Virus</p>  	<ul style="list-style-type: none"> • Electron microscopic • Display both living and non-living characteristics • Multiply only inside the living cells • No cellular organization • They do not show the living characteristics such as respiration and growth 	<ul style="list-style-type: none"> • Influenza virus • HIV • Ebola virus • Dengue virus

* Several enlarged diagrams of microbes are given in the above table. Memorization of the scientific names is not needed.

1.2 Environments and substrates of micro-organisms

Micro-organisms live within all the eco systems on the Earth where other living organisms survive. Microbial world spreads among soil, water and for about up to 6 km of the atmosphere. These organisms survive even on and within the body of plants and animals. Meat, fish, fruits, vegetables, human skin, mouth, alimentary canal, urinary tract are specific substrates that micro-organisms grow.

Microbes can survive even under extreme environmental conditions. Hot water springs, salt marshes, liquids such as petrol, diesel are some such environments.

1.3 Effects of micro-organisms

Micro-organisms have been used in different industries by human from the past. Micro-organisms are beneficial for environment equilibrium. But, they are harmful to human because they act as pathogens and spoil food.

1.3.1 Beneficial effects of micro-organisms

Micro-organisms are used in agriculture, medicine, conservation of environment and in different kinds of industries in seek of economical advantages and for research purposes. here we will investigate how they are being used in different fields.

Applications of micro-organisms in agriculture

● Gene technology

In agriculture, crop harvest is enhanced and enriched by producing drought resistant and pest resistant crops, and crops with high nutrients and taste. Further, biological pesticides and weedicides are developed using micro-organisms.



Golden Rice

Normal Rice

Figure 1.1

Genes of the bacterium *Erwinia uredovora* is used in developing golden rice enriched with vitamin A (figure 1.1).

Genes of the bacterium *Bacillus thuringiensis* is muted in *Zea maize* genome to produce toxins to crop pests.

● Nitrogen fixation

Even though 78% of Nitrogen exists naturally in the atmosphere, plants have a limited-ability to absorb it directly. But *Rhizobium*, a type of bacteria that lives on the nodules of legumes such as beans, peas has the ability to absorb atmospheric Nitrogen directly. This process is known as **Nitrogen fixation**. Commercially produced *Rhizobium* is used in cultivation lands in order to increase the yield of legumes.



Figure 1.2 - Nodules of legumes

Azotobacter a free living Nitrogen fixing bacteria, is directly added to the cultivation lands. They are known as **bio fertilizers**. Bio fertilizers are the substances which make the soil rich with nutrients by using micro-organisms.

- **Producing compost**

Compost is prepared by rapid decomposition of organic matter by micro-organisms. Compost adds mineral to the soil systematically and makes favourable conditions for plants to grow. The organic matter in compost are often decomposed by bacteria and fungi.



Figure 1.3 - Producing compost by using organic matter

- **Bio-pesticides**

Some of the micro-organisms can be used as **bio pesticides** to control insect pests that cause damage to the crops.

e.g. The fungus *Alternaria* is used to combat the aquatic weed, salvinia.

Applications of micro-organisms in medicine

Use of micro-organisms to treat the diseases caused by another micro-organism is very common in medicine. Micro-organisms are used to produce antibiotics, vaccines and anti-toxins.

- **Producing antibiotics**

Chemicals produced in the body of a microbe to destroy or sabotage another micro-organism are known as antibiotics.

Fungi and bacteria are used to produce antibiotics. Antibiotics can kill bacteria and fungi but they do not fight against infections caused by viruses.

Although, antibiotics are not much harmful to human they can cause side effects if used without medical advice.

Penicillin, Amoxicillin, Tetracycline, Erythromycin are used against bacterial infections while **Griseofulvin** is used against fungi infections.

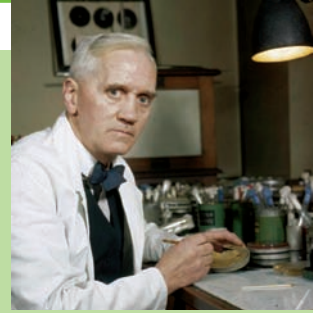


Figure 1.4 - Some antibiotics



For extra knowledge

- The antibiotic, Penicillin was discovered by the Scottish scientist Alexander Fleming.
- It is produced using the fungi *Penicillium notatum*.



Alexander Fleming

• Producing vaccines

A vaccine typically contains an agent that resembles a disease causing micro-organism; and is often made from weakened or killed forms of the microbe or from its toxins.

- Vaccines made from weakened microbes
e.g. Polio, Tuberculosis, Measles
- Vaccines made from killed microbes
e.g. Cholera, Influenza, Typhoid
- Vaccines made from toxins of microbes
e.g. Tetanus, Diphtheria
- Vaccines made from body parts of microbes using genetic engineering
e.g. Hepatitis B



Assignment 1.2

Collect information about the immunization programmes conducted in Sri Lanka.
Display the collected information in a wallpaper in the classroom.

• Producing anti toxins

Bio-chemical substances produced by pathogenic bacteria which harm the host's activity is known as **toxins**. Vaccines are synthesized using these toxins by removing toxic components.

e.g. Tetanus

Applications of micro-organisms in industries

Various strains of microbes are used for research and economic benefits. Using micro-organisms in industrial activities for economic benefits is known as **Industrial Microbiology**.

Micro-organisms are commonly used in following large scale and small scale industries.

- Producing dairy products (yoghurt, curd, cheese, butter)
- Producing biogas
- Metal extraction
- Products based on plant fibres
- Producing alcohol
- Producing vinegar
- Bakery industry



For extra knowledge

Industry	Micro-organisms
Producing alcohol	<i>Saccharomyces cerevisiae</i>
Producing vinegar	<i>Acetobacter aceti</i>
Bakery industry	<i>Saccharomyces cerevisiae</i>
Producing dairy products (yoghurt, curd, cheese, butter)	<i>Lactobacillus bulgaricus</i> <i>Streptococcus thermophilus</i>
Producing biogas	<i>Methanococcus</i> , <i>Methanobacterium</i>
Products based of plant fibres	<i>Bacillus corchorus</i> , <i>Bacillus comesii</i>
Metal extraction	<i>Acidithiobacillus ferrooxidans</i> <i>Thiobacillus ferrooxidans</i>

● Producing biogas

A mixture containing organic materials such as straw, cow dung and water is used to produce biogas. Anaerobic bacteria such as *Methanococcus* react on these organic surfaces and biogas is produced. Biogas mainly consists of Methane gas. Therefore, it can be used as an energy source.

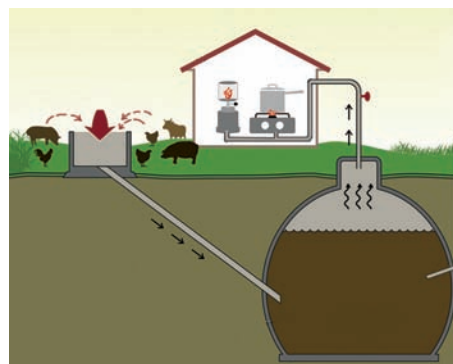


Figure 1.5 - Producing biogas

● Metal extraction

The most simple and effective technology for metal extraction from low grade ores by the use of microbes is known as **bio-leaching**. Uranium and Copper are such two metals that are extracted by bio-leaching.

• Milk based products

Let us do activity 1.1 to demonstrate production of yoghurt.



Activity 1.1

You will need:- Pure cow's milk, yoghurt sample for culture, sugar, gelatin, a pan to boil milk, some plastic cups, a thermometer

Method :-

- Heat cow's milk for 15-30 minutes in a temperature between 88°C - 95°C .
- Remove the cream.
- Add sugar and gelatin as required.
- Add culture yoghurt sample to the milk in small amount in 60°C temperature and mix well.
- Put the mixture into plastic cups.
- Keep the mixture for 6 - 7 hours in the temperature between 40°C - 45°C .
- Cover the cups and keep in the refrigerator (under 4°C).

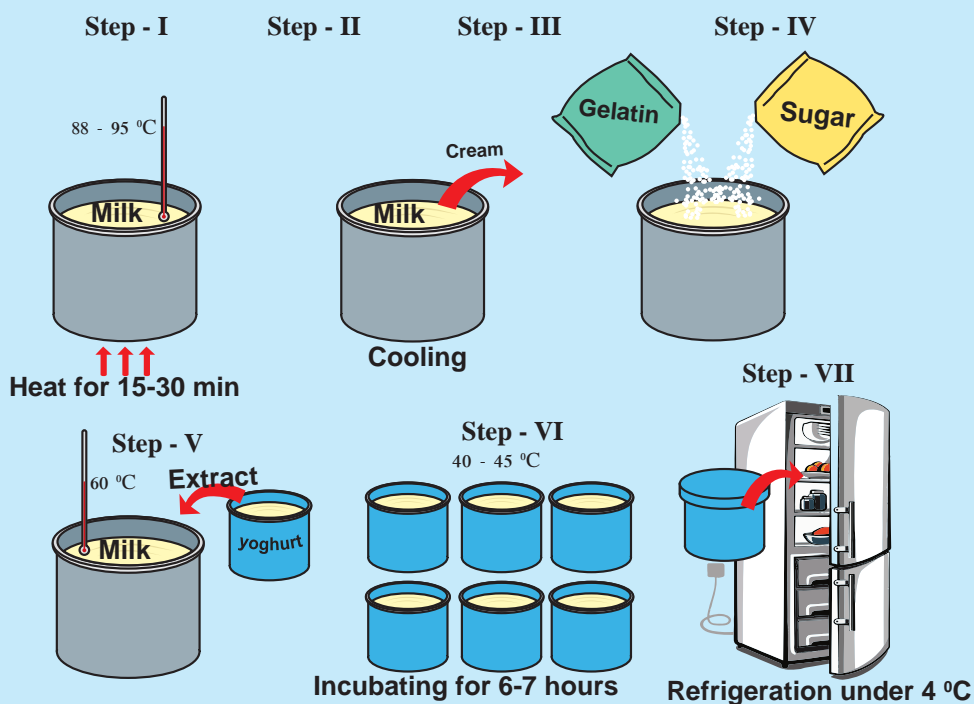


Figure 1.6

When boiling, unfavourable bacteria in milk get destroyed. *Lactobacillus* and *Streptococcus* are used as culture in producing yoghurt. They turn Lactose into Lactic acid. Since it creates an acidic medium, growth of other micro-organisms gets retarded and enhanced preservation. Refrigerating further retards bacteria growth.



Figure 1.7 - Dairy products (yoghurt, curd, cheese, butter)

● **Product based on plant fibres**

Plant fibres are used for various products and these fibres are separated by using bacteria. Coconut, hemp, palmyrah, agave plants are used to get fibre. The compound Pectate which is among the fibres keep them bound together. The Pectinase enzyme which is produced by the relevant bacteria helps to separate these fibres by digesting Pectate.



Figure 1.8 - Crushing coconut husk

Applications of micro-organisms in environmental conservation

Micro-organisms are commonly used for environmental conservation. The technology used to remove environmental pollutants using micro-organisms is known as **bio-remediation**.

Following are some instances where bio-remediation is applied.

- Microbes are used to decompose the organic waste matter in polluted water.
- *Pseudomonas*; a kind of a bacteria which is released on to the ocean water for the decomposition of oil layer on the ocean. An enzyme released by these micro-organisms decomposes the hydrocarbons in oil.
- Heavy metals such as Chromium (Cr), Lead (Pb), Mercury (Hg) are released to the environment from different industries. This polluted water is sent through a tower which contains bacteria to remove these toxic heavy metals from water.
- To produce bio-degradable plastics (plastics that are decomposed by bacteria)

We have discussed the favourable impacts of micro-organisms. Based on the following features micro-organisms are used in economically important large-scale productions.

- Their biological processes occur very rapidly as their growth rate and metabolic rate is high.
- Various strains/varieties of microbes exist that are capable of acting and multiplying on various substances.
- Since micro-organisms possess simple genes they can be easily used for genetic engineering. Hence, microbes are often used for modern genetic engineering.
- The majority of micro-organisms can be obtained at very low rates or free of charge from the environment to use in industries.
- Though, large amount of energy is required for other industries, a small amount of energy is required for industries using microbes.
- Though, most of the industries cause heavy environmental pollution and serious environmental deterioration, the industries with microbes cause minimal environmental damages.



Assignment 1.3

Gather information regarding application of micro-organisms in environmental conservation. Prepare an article to present in the wallpaper.

1.3.2 Adverse effects of micro-organisms

Causing diseases for man, plants and animals that are economically important for man, food spoilage and economical damage to non-living surfaces are several adverse effects of microbes. Biological weapons are another instance where man uses microbes adversely.

Causing diseases

Bacteria, viruses, fungi and protozoa are the groups of micro-organisms that cause diseases. A micro-organism that has the potential to cause a disease is called a **pathogen**. Mosquitoes and flies are **vectors** which carry the pathogen to the host. **Host** is an organism, who provide it's body inside or outside as the substrate to growth of pathogen.

e.g. Viruses act as the pathogen for Dengue disease, while mosquitoes are the vectors. Symptoms appear on man, who is the host.

● Diseases caused by micro-organisms for human

Microbial infections spread by air, water, food, contact and vectors etc. Pathogenic micro-organisms cause different infections to human beings through various methods. Information of such infections is given in table 1.2.

Table 1.2 - Information of diseases caused by micro-organisms for human

Pathogen	Disease	Method of spread	Way the pathogen enters the body
Virus	Cold	Air	Through respiratory system
	Dengue	Mosquito vectors	Through the skin by mosquito bites
	AIDS	Blood and other fluids of an infected person	Through sexual contacts or blood transfusion
Bacteria	Tuberculosis	Air	Through respiratory system
	Typhoid fever	Polluted food and vectors such as housefly	Through digestive system with food
Protozoa	Malaria	Mosquito (vectors)	Through the skin by mosquito bite
	Amoebic dysentery	Polluted water and food	Through digestive system
	Leishmaniasis	Vectors such as sand fly	Through open wounds on the skin
Fungi	Pityriasis	Contact of an infected person or through clothes of an infected person	Through skin
	Rashes		

* The bacterium *Bacillus thuringiensis* is used as a biological control to destroy the larval stages of dengue mosquitoes.



For extra knowledge

Leishmaniasis is a disease caused by a protozoan. It is spread by the bite of Sand-fly which acts as the vector. The protozoan can enter through skin ulcers. Then, it infects the skin, mouth and nasal path. Skin ulcers, fever, reducing red blood cells and enlarging liver are symptoms of leishmaniasis.



● Diseases caused by micro-organisms to plants

Some of the diseases caused by micro-organisms to plants are given below.

Powdery mildew disease

Powdery mildew is a disease caused by a fungus. The leaves, stem, flowers and fruits of the plant are affected by this disease appearing white or gray colour powdery material is the main symptom of infected parts. This disease damages every part of the tree (figure 1.9).

Late blight

Potato plant is commonly affected by this disease which is caused by a fungus. Brown spots can be seen on the leaves and later they turn into black. Then, the whole tree gets affected by the disease (figure 1.10).

Wilting

Fungi or bacteria cause this disease. The xylem of the plants which transports water throughout the tree gets affected from this disease. Later the xylem does not function properly due to damage. Therefore, the whole plant gets withered due to poor supply of water (figure 1.11).



Figure 1.9 - Grapes with powdery mildew disease



Figure 1.10 - Potato plant with late blight



Figure 1.11 - Tomato plant with bacterial Wilting

Food spoilage caused by micro-organisms

Micro-organisms multiply on food as food has the necessary factors for the growth of micro-organisms. Micro-organisms convert the components of the food into unfavourable materials or they add toxic materials to food. Due to this reason the nature of the food is changed. The change of physical and chemical nature of food makes the food unfit for consumption. This process is known as food spoilage.

(You have learnt about food spoilage such as fermentation of carbohydrates, putrefaction of proteins and rancidification of lipids in grade 8).

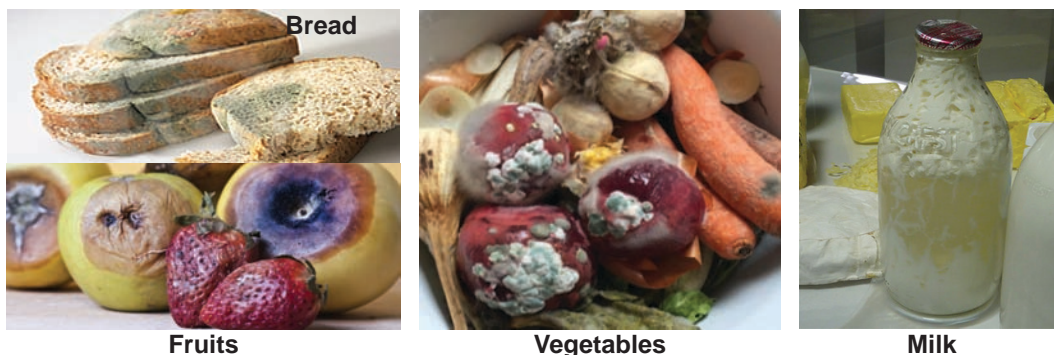
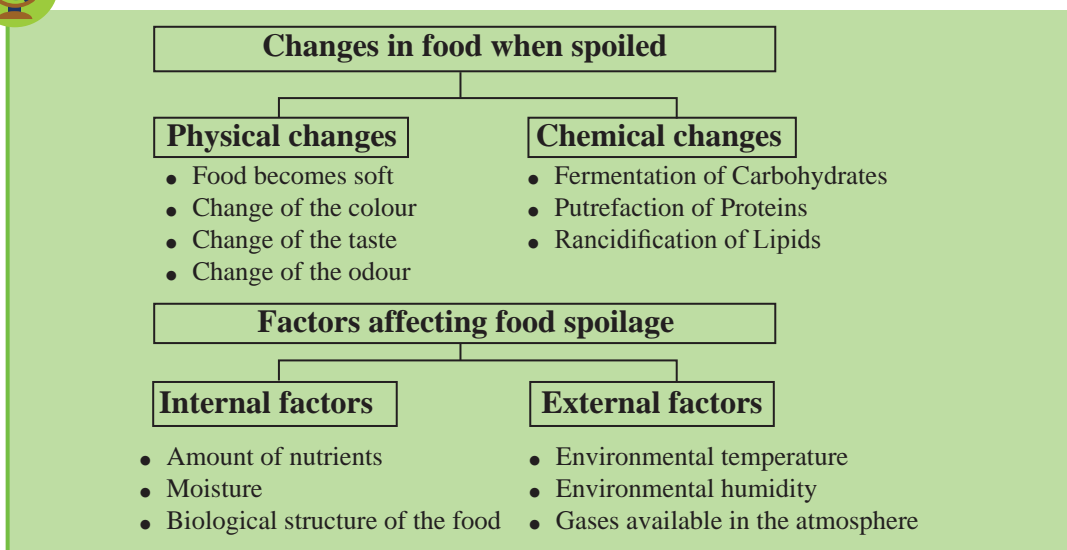


Figure 1.12 - Food spoilage caused by micro-organisms



For extra knowledge



Applications of micro-organisms as biological weapons

The toxins produced by micro-organisms or harmful pathogenic bacteria or virus which are used for military purposes are known as **biological weapons**.

Bacillus anthracis causative agent of Anthrax disease is considered as most harmful biological weapon at present. These biological weapons are very much harmful to human, other animals and plants.



Assignment 1.4

Conduct a debate under the following topics regarding micro-organisms

- **Proposing team** - Micro-organisms are mostly useful to the living beings.
- **Opposing team** - Micro-organisms are mostly harmful to the living beings.



Summary

- Micro-organisms are unicellular or multicellular organisms which cannot be seen clearly with the naked eye.
- The main micro-organism categories are bacteria, fungus, algae and protozoa.
- Viruses have living and non-living characteristics but they also studied in microbiology.
- Micro-organisms live within all the eco-systems with favourable environmental conditions and even under the extreme environmental conditions.
- Micro-organisms are used in various fields such as agriculture, medicine, industries and for environmental conservation.
- Food spoilage, diseases damage done to the economically important surfaces and use of micro-organisms as biological weapons are some adverse effects of micro-organisms.

Exercise

01) Select the correct or most suitable answer.

1. A group of autotrophic micro-organism is
1. virus 2. fungi 3. algae 4. protozoa
2. Toxic chemicals produced in the body of a microbe to destroy or sabotage an another micro-organism is called as
1. antibodies 2. anti nutrients 3. antiseptic 4. antibiotics
3. Some characteristics of viruses are given below.
a. No cellular organisation
b. Multiply only in living cells
c. Do not show the living characteristics such as respiration and growth.
The correct statements of the above are;
1. a and b 2. a and c 3. b and c 4. a, b and c
4. A disease caused by bacteria is
1. Malaria 2. Tuberculosis 3. Rabies 4. Ebola
5. The technology used to remove the environmental pollutants by applying micro-organisms is known as
1. bio-control 2. bio-degradation
3. bio-remediation 4. bio-leaching

02) State whether the following statements are true (✓) or false (x).

1. Antibiotics are any chemical substance that is used to destroy or deactivate micro-organisms. ()
2. The vaccine given for tetanus contains weakened bacteria toxins. ()

