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High School Sciences Students' ideas about Microorganisms and their Importance

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Abstract

The purpose of this study is to ascertain how much high school pupils understand about microorganisms and their significance. Sixty secondary students from a scientific high school made up the study samples. After discussing the issues of microorganisms, the students were given their questionnaire back to determine their level of improvement and to let them know that microbes are not always beneficial. To dispel some popular misconceptions regarding microorganisms, students were given examples of both beneficial and hazardous microbes. Although microbes are not a major part of their biology classes, it was discovered that the students are aware of them and have usually positive opinions about them because of their advantages. Our research's objectives were to assist students in avoiding infections by various means, distinguishing between the significance of sterilizers and disinfectants, avoiding the negative impacts of certain bacteria, and, lastly, attempting to capitalize on helpful species. It is also anticipated that the message will spread outside of the participants when students tell their friends and family about their experiences. We hope to increase understanding of the significance of microbiology and its dual functions as both beneficial and dangerous to humans through this teaching method.

Key words:

Microorganisms, Questionnaire, Contamination, Disinfectant, High school students.

1.Introduction:

Microbiology is a notion that we should face in the sciences, life, and biotechnology. It is used in many different fields, including novels, journals, TV, newspapers, and the like. Due to advancements in hygiene and illness awareness as well as a rise in biotechnology consciousness, people are now more mindful of microbes and their significance. In this regard, it is critical that people are aware of and knowledgeable about this field. According to studies, people today have different ideas regarding the benefits of microbes for humans. (Sinatra et al. 2003).

The contamination by microorganisms pose an important role to public health and safety in various fields, including food processing facilities, hospitals, and even our everyday surroundings. Microorganisms have different types such as bacteria, archaea, algae, fungi and viruses, can cause a lot of diseases leading to widespread outbreaks if not effectively controlled. Recognizing the importance of combating microorganism contamination, it becomes imperative to involve the younger generation in this critical fight (Arroita et al ., 2022).

Understanding that not all germs are dangerous and pathogenic is crucial. In actuality, a large number of microorganisms contribute significantly and favorably to our life. For instance, microbes promote agriculture through nitrogen fixation and mycorrhizal relationships with plant roots, which improve soil fertility and plant growth. They also aid in the recycling of organic matter and aid in the nitrogen cycle. Additionally, microbes are used in a variety of businesses, including the food production process, which includes fermentation, which produces goods like cheese, yogurt, bread, and milk. The creation of proteins, antibiotics, alcohol, vitamins, acids, enzymes, and medications is made possible by microorganisms, which are also crucial in the biotechnology industry. Additionally, many microbes can bioremediate contaminants such dyes, heavy metals, toxins, plastics, and phenols, which helps with environmental cleanup (Aydın 2015).

Numerous well-known human illnesses, including cholera, tetanus, typhoid, salmonella, bacterial dysentery, diphtheria, TB, pneumonia, malaria, and amoebic dysentery, are brought on by microorganisms. Food deterioration is caused by microbes. The two main microbial agents of breakdown in aerobic conditions are bacteria and fungi. In oxygen-deficient settings, bacteria take over. According to Dawson and Schibeci (2003), spoilage bacteria are microorganisms that cause food to decay and acquire an unpleasant odor.

One promising demographic that can actively participate to resolving this issue is high school students. We can enable students to become change agents in their communities by giving them real-world, hands-on experiences. In order to actively engage high school students in the battle against microbe contamination, this essay examines the idea of bringing learning outside of the classroom and into the field.

We can provide high school pupils a thorough grasp of microbes' function in our lives by introducing them to both their advantages and their threats. Students will be able to actively contribute to the control of microorganism contamination and make well-informed judgments thanks to this information.

This essay will emphasize the advantages of microorganisms and go over some tactics and projects that may be used to get high school students involved in the battle against microbial pollution. We will examine useful strategies that enable students to actually change the world, from lab tests to community service initiatives. We may inculcate lifetime habits of cleanliness and hygiene and cultivate a sense of responsibility by actively engaging children in practical activities.

In the end, we may produce a generation that is not only aware of microbe contamination but also actively dedicated to preventing it by utilizing the vigor and excitement of high school students. Through their work, we can look forward to a safer, cleaner future where the dangers posed by microbes are reduced and their advantages are used to advance society.

2.Theortical framework:

Simmoneaux (2000) employed interviews to assess students' understanding of the concept of "germs" or "microbes." The pupils claim that viruses are more harmful to humans than bacteria and that health problems only occur when they are present in large amounts. The survey found that students thought the food industry was the main application for microorganisms. Students reported that they learned the most about bacteria, viruses, and germs from media, TV cartoons, school-based AIDS awareness campaigns, and other sources in addition to their studies at school.

Jones et al. (2013) tried to find out what university students knew and did before and after completing microbiology lessons. They found that the children's understanding had increased. Additionally, some of their behaviors remained the same, such as eating, drinking, and kissing, as well as placing their hands on a public restroom door handle or shaking their hands, even though some of them changed, such as using a public phone, reaching for a restroom faucet, handling money, borrowing, taking out the trash, working in the mud without gloves, and borrowing soap from a friend while camping.

3. **Methods of Research and the tools used**

Sampling, survey, field study and images.

3.1. Sampling

Sixty secondary students from El Mostakbal Distinctive Governmental Language School 4, a science high school, made up the study sample. Because science high schools prepare students who wish to pursue science-related fields in higher education, these pupils were chosen. The age range of the students was 16–18 years old. An examination of these pupils' microorganism knowledge will reveal information about their scientific education level.

3.2. Survey

The researcher reviewed their biology curriculum and using a descriptive survey model, the Microorganisms Knowledge Test (MKT). There are six open-ended questions on it. By employing the content analysis method to examine the test results, the researcher transformed the qualitative data acquired from the Microorganisms Knowledge Test into quantitative data. After reading each student's response on their own, the researcher compared and evaluated how consistent it was, then calculated and presented in a table. The position of microorganisms in the course material and the degree to which students learn about them were examined in the document review.

The survey

1) What is a microorganisms?
a. They are harmful organisms
b. They are useful organisms
c. They are visible organisms by naked eye
d. They are visible by microscope
e. They are living organisms
f. They are non-living organisms

2) Where do you find microorganisms?
a. In everywhere
b. In human body
c. In soil
d. In air
e. In water
f. In dirty places

3) From which of the following is considered microorganisms?
a. Bacteria
b. Yeast
c. Fungi
d. Algae
e. Viruses
f. Archaea

4) Benefits of microorganisms?
a. It produces antibiotics
b. It digest the cellulose in animal body.
c. It synthesises vitamins
d. It cases nitrification
e. It cases food spoilage.
f. Its produces proteins

5) Harmful of microorganisms?

a. It causes human diseases
b. It causes rot and mould.
c. It infects wounds.
d. It causes bad odour
e. It's used in dairy products.
f. It causes food poisoning

6) How can we get rid of microorganisms?
a. by alcohol
b. by water only
c. by soap and water
d. by chlorine
e. by heat
f. by soap only

3.3. Field study and images
Many pictures of different types of microorganisms that infect food in our daily life as well as their shapes in the petri dishes through their growth were shown to the students.

3.4. Results of field study:

We asked the students six open ended questions.
1) What is a microorganisms?
2) Where do you find microorganisms?
3) Microorganisms that you know?
4) Benefits of microorganisms?
5) Harmful of microorganisms?
6) How can we get rid of microorganisms?

We analysed students' responses and calculated each response based on number of students, putting the data in the following tables:

1) What is a microorganisms?

Students' responses	Number	Percentage
They are harmful organisms	42	70%
They are useful organisms	9	15%
They are visible organisms by naked eye	2	3.3%
They are visible by microscope	3	5.1%
They are living organisms	2	3.3%
They are non-living organisms	2	3.3%

2)Where do you find microorganisms?

Students' responses	Number	Percentage
In everywhere	35	58.2%
In human body	10	16.7%
In soil	5	8.4%
In air	5	8.4%
In water	1	1.6%
In dirty places	4	6.7%

3) Microorganisms that you know?

Students' responses	Number	Percentage
Bacteria	30	50%
Yeast	5	8.4%
Fungi	10	16.7%
Viruses	15	25%
Algae	0	0%
Archaea	0	0%

4) Benefits of microorganisms?

Students' responses	Number	Percentage
It produces antibiotics	30	50%
It digest the cellulose in animal body.	5	8.3%
It synthesises vitamins.	0	0%
It's used in dairy products.	0	0%
It cases nitrification.	0	0%
Its produces proteins	25	41.7%

5) Harmfull of microorganisms?

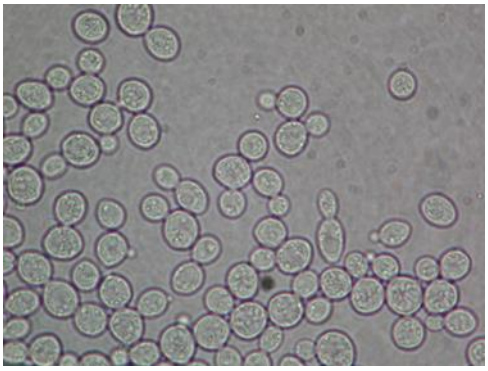
Students' responses	**Number**	**Percentage**
It causes human diseases	**25**	**41.7%**
It causes rot and mould.	**10**	**16.8%**
It infects wounds.	**5**	**8.3%**
It causes bad odour	**5**	**8.3%**
It cases food spoilage	**5**	**8.3%**
It causes food poisoning	**10**	**16.8%**

6) How can we get rid of microorganisms?

Students' responses	Number	Percentage
By alcohol	15	25%
By water only	0	0%
By soap and water	25	41.7%
By soap only	5	8.3%
By chlorine	5	8.3%
By heat	10	16.8%

3.4 Field study and images

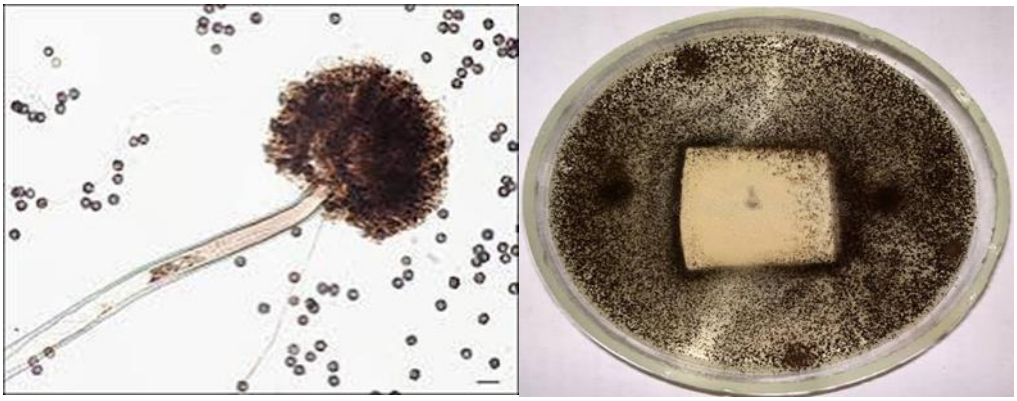
A variety of fermented foods and beverages produced by microbes



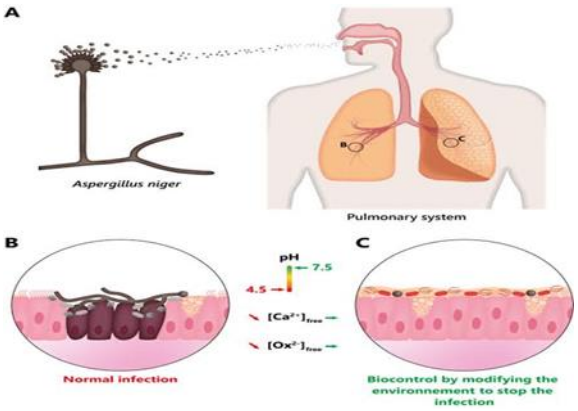
1-*Saccharomyces cerevisiae*

Brewer's yeast is used in baking and brewing and is necessary for fermentation. It may also be a useful treatment for diarrhea due to its probiotic properties. Other digestive system conditions have been treated with it.

2-*Aspergillus niger*

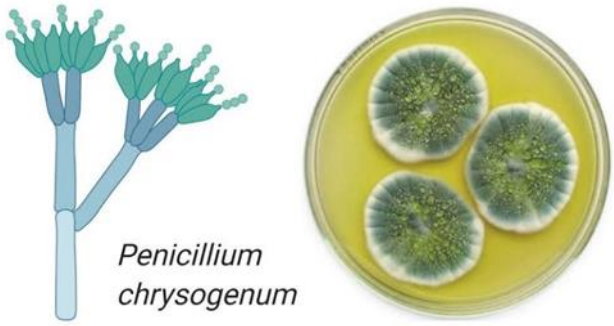


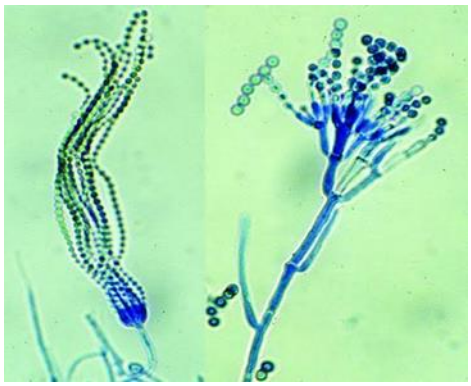
Spores of both indoor and outdoor Aspergillus mold species are the source of the fungal infection known as aspergillosis. Owing to A. niger's widespread distribution, people frequently breathe in its spores from their surroundings.



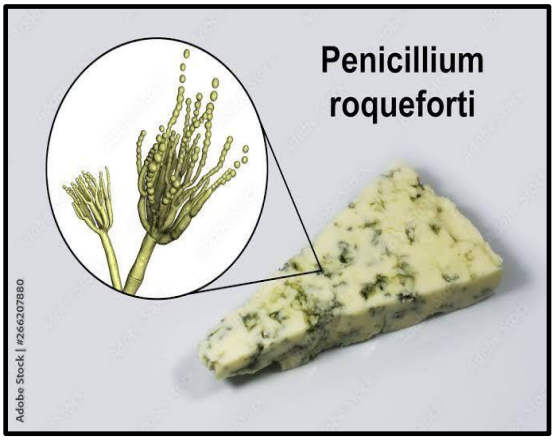
3- *Penicillium*

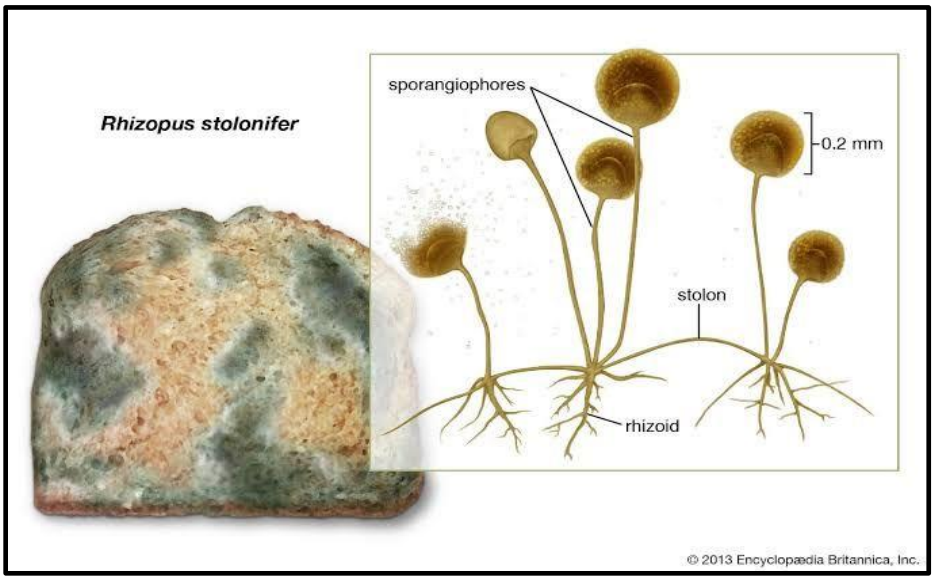
Blue cheeses, flavorings, antifungals, polysaccharides, proteases, and other enzymes are the main industrial products made from this fungus.





The major industrial use of this fungus is the production of blue cheeses, flavouring agents,





4- *Rhizopus stolonifer* on bread

Harmful Applications:

causes food to decay by rotting fruits and vegetables.
Mucormycosis is one of the major fungal illnesses that it can cause in humans.
- Grows on bread and foods high in carbohydrates, spoiling them.
Food contamination may result in the production of toxic mycotoxins.
- Destroys organic items that have been kept, such seeds and grains.

Beneficial Applications:

utilized in the synthesis of lactic acid, a crucial component of the food and pharmaceutical sectors.
Aids in the fermentation procedures used to make tempeh and other meals.
Utilized in studies on the growth and reproduction of fungi.
Participates in the synthesis of certain biochemicals and antibiotics.
By decomposing organic matter, it aids in waste management and biodegradation.


5- *Agaricus* fungi, particularly *Agaricus bisporus*, which is the most widely cultivated mushroom species, play an important role in various fields.

Significance:

1. Nutritional Value

Button mushrooms, or Agaricus bisporus, are a good addition to many diets because they are low in calories, fat, and cholesterol and rich in minerals, including potassium, copper, and selenium, as well as vitamins, particularly B-vitamins like riboflavin, niacin, and pantothenic acid**.**

2. Medicinal Uses

According to some research, they include substances that may strengthen the immune system, prevent some cancers, and reduce inflammation. For instance, the species Agaricus blazei has been studied for its possible anticancer effects and immune-boosting capabilities.

3. Economic Importance

Agaricus mushrooms are one of the most commercially important fungi that are cultivated for food. In many parts of the world, they are an essential component of agriculture and support local economies.

4. Environmental Role

Agaricus fungi are saprophytic organisms that are crucial to the breakdown of organic matter and the recycling of nutrients into the environment. They are therefore essential to preserving the fertility and health of the soil.

Some aspects of Agaricus fungi can be harmful:

1. Toxicity of Other Species

Symptoms such as diarrhea, cramping in the stomach, nausea, and vomiting might result from consuming the incorrect species of Agaricus.Not every species of Agaricus is edible. Within the genus, some toxic or non-edible species can mimic edible ones, causing confusion and unintentional poisoning.

For example:

Consuming Agaricus xanthodermus, commonly referred to as the "yellow-staining mushroom," may result in gastrointestinal upset. Its flesh turns yellow when sliced or bruised, indicating that it is poisonous.

2. Allergic Reactions

Agaricus bisporus is one of the mushrooms that some people may be allergic to, which can cause symptoms including skin rashes, trouble breathing, or stomach issues after eating.Anaphylaxis, a potentially fatal allergic reaction, can occasionally occur in patients with severe mushroom allergies.

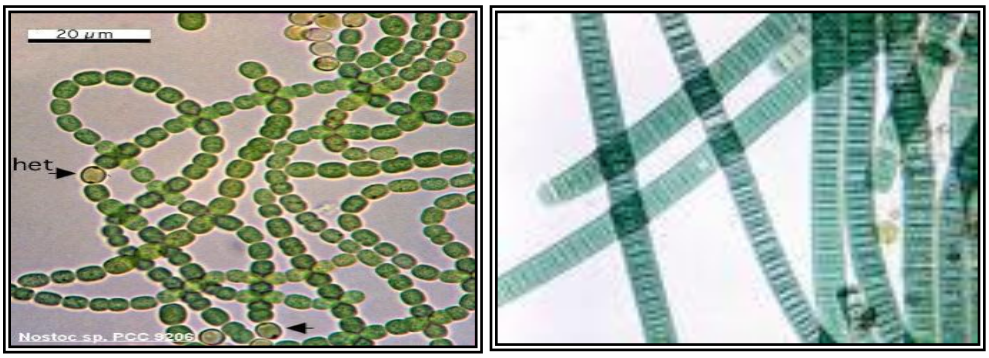
3. Contaminants in Cultivated Mushrooms

Chemical or pesticide contamination: Agaricus species and other mushrooms are susceptible to accumulating toxic chemicals or pesticides from their growing environment. Eating these tainted mushrooms may be harmful to your health. • Mushroom-borne pathogens: Similar to other mushrooms, agaricus mushrooms may become contaminated during incorrect handling or storage by bacteria or fungi (such Aspergillus species), which could result in foodborne diseases.

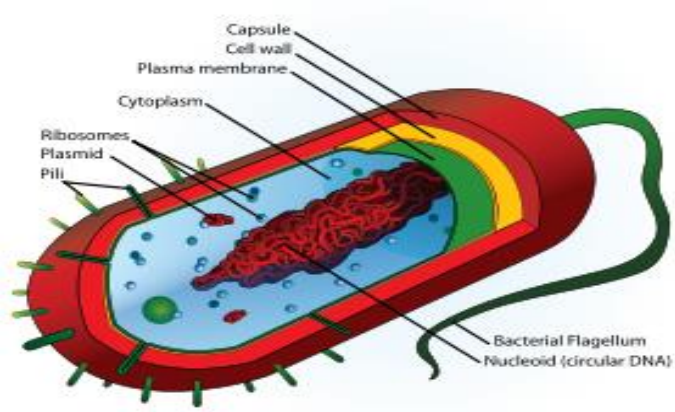
4. Heavy Metal Accumulation

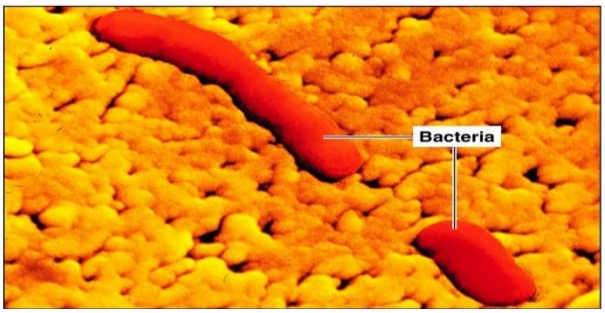
Agaricus species are among the mushrooms that have the ability to absorb heavy metals from their growing media. They can collect harmful levels of elements like cadmium, lead, or mercury if they are grown in contaminated soil, and consuming excessive amounts of these compounds over time may be harmful to one's health.

6- Algae under microscope



7- bacteria





5. Interpretation of Results

According to this study, students have certain misconceptions about microorganisms. For instance, the majority of students (70%) believe that germs are dangerous, whereas only nine students (15%) believe that they are beneficial. According to Simonneaux's (2000) study and Arroita et al. (2022), the majority of students concur that microbes are tiny, living things that can be observed under a microscope (Table 1).

Furthermore, the majority of students (58.2%) believed that microorganisms were present everywhere, 8.4% believed that they were present in soil, 8.4% believed that they were present in the air, 6.7% believed that they were present in unclean places, 16.7% believed that they were present in the human body, and only 1.6% believed that they were present in the water, which is consistent with Simonneaux's (2000) earlier study (Table 2).

According to the questionnaire, students also disregarded other groups of microorganisms besides viruses and bacteria. The majority of students selected bacteria (50%) as their first choice, followed by viruses (25%). This is consistent with a study by Jones and Rua (2006) that found that most students first associate the concept of microorganisms with viruses and bacteria, followed by fungi (16.7%) and yeast (8.4%). Additionally, none of the students believed that microorganisms are algae or archaea (Table 3). In a similar vein, Aydın (2015) found that few students considered algae and archaea to be microorganisms.

In line with Arroita et al.'s (2022) research, which found that most students overlook the decomposition process carried out by microorganisms, 30 students (50%) believed that microorganisms produce antibiotics, 5 students (8.3%) believed that microorganisms aid in the digestion of cellulose in animal bodies, and none of the students believed that microorganisms are used in dairy products, soil nitrification, or vitamin production. whereas 25 students (41.7%) believed that proteins are produced by microbes (Table 4).

According to the survey, the majority of students (41.7%) thought that they could get rid of germs by using soup and water, 25% thought that they could get rid of them by using alcohol, 16.8% thought that they could get rid of them by using heat, 8.3% thought that they could get rid of them by using chlorine, and 0% thought that they could get rid of them by using only water (Table 6).

6. Conclusion

This study examines high school students' understanding of microbes and how they relate to the biology curriculum. Microorganisms are mentioned in the ninth, eleventh, and twelfth grade curricula's principles, objectives, and particular activities. However, the subject is handled under other titles, such "bacteria" or "viruses." Microorganisms, a broader subject, is not discussed. Microbes are understood by students in spite of this situation. When students hear the term "microorganism," they usually think of viruses and bacteria. One possible explanation for this could be the prominence of viruses and bacteria in the curriculum. Additionally, people are aware of bacteria and viruses because they are the source of many illnesses and are commonly used in biotechnology (Simonneaux, 2000, 619–644).

Students' understanding of germs is greatly influenced by TV shows. Similarly, Jones and Rua (2006) claim that the media has a big impact on how all pupils perceive the concept of microorganisms. Bacteria and viruses are the most well-known microbes for all of these reasons.

We employed field research, experiments, and questionnaires as methods. In addition to showing them samples of Salmonella, Penicillium on oranges, Aspergillus on bread, Fungi on peppers, and Bacterial spots on tomato fruits, we also used a questionnaire to assess students' understanding of microorganisms.

According to the study's findings, youngsters don't know enough about microbes, and only a small portion of students possess precise understanding about them. Students were given access to six open-ended questions.

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1) What is a microorganisms?

2) Where do you find microorganisms?

3) Microorganisms that you know?

4) Benefits of microorganisms?

5) Harmful of microorganisms?

6) How can we get rid of microorganisms?

After reviewing the students' responses, we assigned a weight to each response according to the total number of students. Students' misconceptions on microbes, for instance, were exposed by this survey. The usage of microbes, for instance, was unfamiliar to the majority of pupils. Microorganisms were perceived as detrimental (74%), beneficial (18%), antibiotic-producing

(9%), easy to digest (8%), dairy-using (0%), improving soil fertility (4%), and decomposing organic matter (4%).

Today, the biotechnology business harnesses microbes to manufacture many of the things we use. In addition to their potential to spread illness, microorganisms have industrial use. To ensure that students acquire scientific facts rather than rumors, the curriculum should also include their application in biotechnology and provide instances of its applications. The absence of biotechnology-focused teachers, their lack of teaching experience, the lack of resources and curriculum, and the short teaching time are the main barriers to teaching biotechnology, according to Dawson and Schibeci (2003). The government must to try to get beyond these obstacles and concentrate particularly on teacher preparation initiatives

Recommendations:

-Including courses at various academic levels that focus on microorganisms.
-Offering the equipment, such microscopes, that students need to learn about microbes.
-Offering experts to instruct pupils.

- Students should be given enough time to study microorganisms.

Acknowledgement:

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References

Arroita, M., Iradi, M., Barrutia, O., Díez, J. R. (2022). Secondary school students' misconceptions about microorganisms. A laboratory sequence to learn about their presence and function, International Journal of Human Sciences Research, 2(18), 2–14.

Aydın, S. (2015). High school science students' ideas about microorganisms and their place in the curriculum. International Journal of Biology Education, 4(2), 108-119.

Dawson, V., & R. Schibeci. (2003). Western Australian students' understanding of biotechnology. International Journal of Science Education, 25: 57-69.

Jones, M.G. & Rua, M.J. (2006). Conceptions of Germs: Expert to Novice Understandings of Microorganisms. Electronic Journal of Science Education, 10 (3), 1-40.

Jones, G., Gardner, G.E., Lee, T., Poland, K., S. Robert. (2013). The Impact of Microbiology Instruction on Students' Perceptions of Risks Related to Microbial Illness. International Journal of Science Education, Part B: Communication and Public Engagement, 3 (3), 199- 213.

Karwowska, E. (2003). Microbiological air contamination in some educational settings. Polish Journal of Environmental Studies, 12, 181-185.

Simonneaux, L. (2000). A study of pupils' conceptions and reasoning in connection with "microbes", as a contribution to research in biotechnology education. International Journal of Science Education, 22(6), 619–644.

Sinatra, G., Southerland, S., McConaughy, F., & J. Demastes. (2003). Intentions and beliefs in students' under-standing and acceptance of biological evolution. Journal of Research in Science Teaching, 40: 510–528.