

SECTION

1

INTRODUCTION TO BIOMEDICAL SCIENCE



BIOMEDICAL SCIENCE IN SOCIETY

Biomedical Science Practice

INTRODUCTION

Biomedical science uses knowledge from biology and other sciences to study diseases and how to treat them. This session will help you acquire knowledge of what biomedical science is about. You will also explore biomedical scientists in practice, products of Biomedical Science, and address some misconceptions of Biomedical Science.

Furthermore, you will explore the role of Biomedical Science as a vital force in tackling health challenges head-on ranging from widespread of diseases to ongoing health issues. You will be introduced to some problems in society and explore how they can be solved by applying biomedical science. You will also learn how to identify some problems outside your community that can be addressed by Biomedical Science.

Lastly, the biological processes and mechanisms underlying human health and disease will be discussed. To understand and solve complex biomedical problems, scientists employ a structured approach known as the scientific method. This method enables researchers to systematically investigate phenomena, formulate hypotheses, conduct experiments, and draw meaningful conclusions. When covering this topic, you will delve into how the scientific method is applied in biomedical science investigations.

Hope you enjoy the fascinating ride in the world of Biomedical Science!

At the end of this section, you should be able to:

- Describe what biomedical science is.
- Identify problems in society that can be solved by applying biomedical science.
- Explain how the scientific method can be applied to undertake investigations or address problems in Biomedical Science.

Key Ideas

- Biomedical science involves understanding how the human body works, how diseases affect it, and how to develop new treatments.
- It also makes use of advanced technologies to study cells, tissues, and organs, aiming to improve health.
- Biomedical science is crucial in developing medical advancements such as vaccines, antibiotics, and medical devices.
- Biomedical science plays a crucial role in diagnosing and treating diseases such as cancer, diabetes, and infectious diseases.
- Biomedical science drives the development of innovative medical devices and technologies, such as prosthetics, assistive devices, and wearable health monitors.

- The scientific method is a systematic approach to problem-solving used in biomedical science.
- It involves several steps: observation, questioning, hypothesis, prediction, experimentation, data analysis, and conclusion.
- Applying the scientific method ensures reliable and valid results in biomedical research.

DEFINITION AND DESCRIPTION OF BIOMEDICAL SCIENCE

Biomedical science can be defined as:

- A combination of various fields of science such as biology, chemistry, physics, and medicine to understand human health and illness (See Fig 1.1).
- An application of science concepts to develop new solutions for human health and well-being.
- An application of scientific knowledge and techniques to investigate the causes, mechanisms, and treatments of health-related problems (See Fig. 1.2).

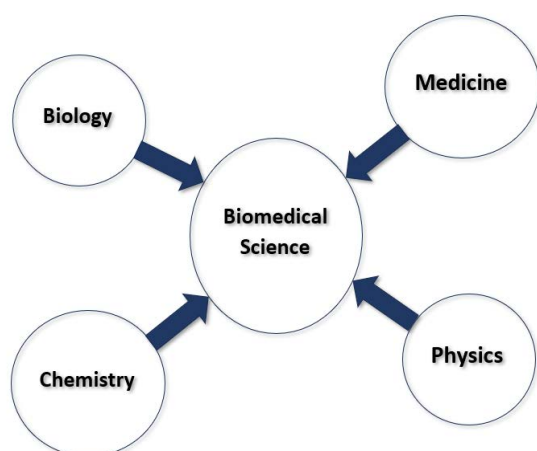


Fig 1.1: Scope of Biomedical Science



Fig 1.2: A biomedical scientist

Key Features of Biomedical Scientists

1. Good scientific knowledge
2. Ethical behaviour awareness
3. Ability to work in teams
4. Commitment to public health
5. Critical thinking and problem-solving skills
6. Good communication skills
7. Attention to details

Biomedical Scientists in Practice and the Products of Biomedical Science

A biomedical scientist is someone who studies how our bodies work and what makes us sick. They do experiments, research to understand diseases and find ways to treat them.

Careers in Biomedical Science

There are many career opportunities in biomedical science. Some careers in biomedical science include nutritionists, physiotherapists, neuroscientists, medical laboratory technicians, microbiologists, biomedical engineers, pharmaceutical scientists, biostatisticians, forensic scientists, and genetic counselling. (See Fig 1.3)



Fig 1.3: A biomedical scientist in practice

Products of Biomedical Science

Biomedical Science covers many different products that help with healthcare, research, and medical progress. Here are some biomedical science products:

1. Diagnostics Tools and Devices

They are used to find out what is wrong with patients. Some examples include X-ray, rapid diagnostic test (RDT) kits such as malaria diagnostic test kit, and pregnancy test kits. (See Fig 1.4)



Fig 1.4 (A) An X-ray image showing a fractured ankle (Kim et al, 2021) and (B) Diagnostic test kit (Gillet et al., 2010)

2. Drugs (Medicines)

Drugs are special substances that doctors give to treat illnesses or make people feel better. They can help with pain, infections, and many other health problems. (See Fig1. 5)



Fig 1.5 Medicines (Hammett, Nd)

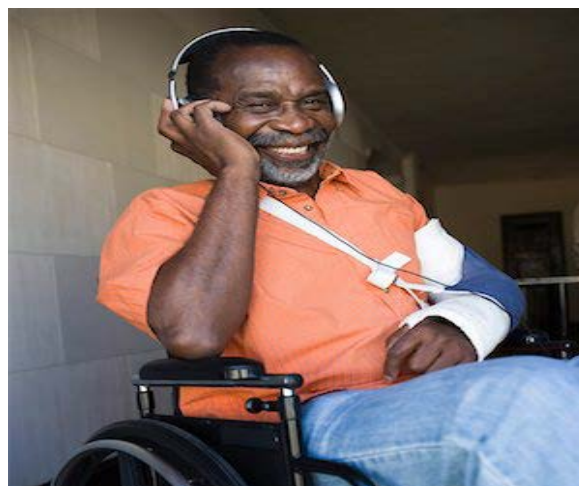
3. Assistive Devices and Implants

Assistive devices and implants are tools that help people, with disabilities or medical conditions, perform everyday activities or improve their body's functions. Examples include *hearing aid*, *wheelchair*, *tooth implant*, *Dental braces*. (See Fig 1.6 & 1.7)



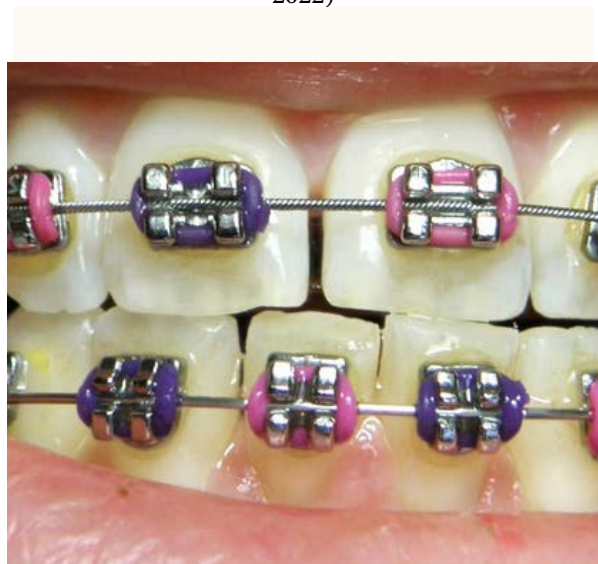
A

Fig 1.6 (A) Child with hearing aid (Clark schools, 2022)



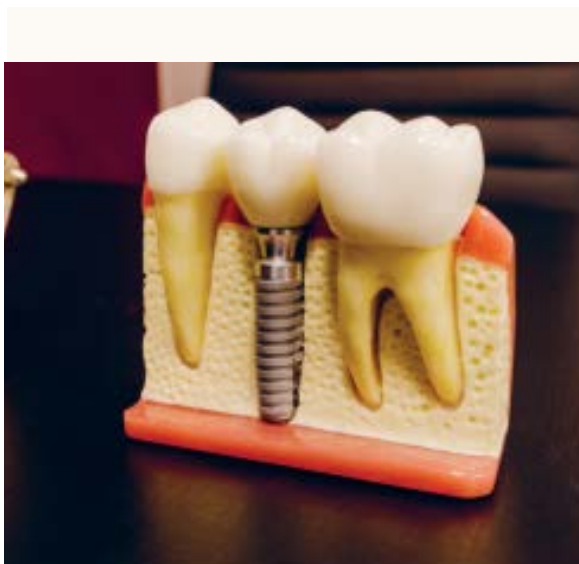
B

(B) Man in wheelchair (Masterfile, 2024)



A

Fig 1.7 (A) Dental braces (Mandal, 2023)



B

(B) Tooth implant (Borba, 2020)

Misconceptions Around Biomedical Sciences

Misconceptions around biomedical sciences are commonly held beliefs or ideas about biomedical science that lack accurate information or understanding.

Below are some misconceptions about biomedical science and their facts:

1. **Misconception:** Biomedical science is the same as medical practice.

Fact: Biomedical scientists support medical practice but they are not directly involved in patient care or treatment.

2. **Misconception:** Biomedical science is only for those pursuing medical careers.

Fact: Biomedical science opens up various career opportunities beyond conventional medical roles.

3. **Misconception:** All biomedical scientists work in laboratories.

Fact: Many biomedical scientists work in laboratories, but they may also work in fields such as public health, policy development, or science communication.

4. **Misconception:** Biomedical science is only about finding cures.

Fact: In addition to seeking cures, biomedical scientists explore what causes diseases, study how they work, create tools for diagnosis, and help us understand more about human health and sickness.

5. **Misconception:** Biomedical scientists are solely focused on human health.

Fact: Though the primary focus of biomedical science is human health, biomedical scientists may study other living organisms to gain insights and develop treatments and interventions for human diseases.

Activity 1: Video on jobs and careers in biomedical science

Click on this [link](#) and watch a video on jobs and career choices in biomedical science.

After you watch the video, identify the different career choices in biomedical science that are new to you.

Activity 2: Encounter with a biomedical scientist

1. Recall the last time you had an encounter with a biomedical scientist like doctors, nurses, medical laboratory scientist, physiotherapists and physician assistants.
2. Share your personal experience interacting with the biomedical scientist with your friends.

Activity 3: Rapid Diagnostic Test (RDT) kit for malaria

1. [Click here](#) to watch a video on rapid diagnostic test for malaria.
2. Carefully observe how malaria test is done using the RDT.
3. How would you know you tested negative or positive from the video?
4. What biomedical product was used for the test?

Activity 4 Assistive devices

1. [Click here](#) to watch a video on assistive devices.

From the video,

- a. Did you identify any examples of assistive devices?
- b. What innovations are being put in place to overcome challenges posed by indoor wheelchairs?

Self-reflection

1. How might your understanding of careers in biomedical science influence your future interactions with healthcare professionals?
2. How do the new career options you have discovered align with your interests and skills?
3. How does your experience in these activities enhance your appreciation of biomedical science products in disease diagnosis?

Extended Reading

- Ahmed, N., Glencross, H., & Wang, Q. (Eds.). (2016). Biomedical Science practice: experimental & professional skills. Oxford University Press.
- Pitt, S. J., & Cunningham, J. (2009). An introduction to biomedical science in professional and clinical practice. John Wiley & Sons. <https://www.ncbi.nlm.nih.gov/books/NBK56989/>

PROBLEMS WITHIN SOCIETY AND HOW BIOMEDICAL SCIENCE CAN BE APPLIED TO SOLVE THESE PROBLEMS.

There are several problems in our society that can be addressed by Biomedical Science.

Below are some health challenges in our society and how biomedical science may be applied to tackle them

1. **Unsafe medicines and herbal concoctions:** In our society, there are challenges with unsafe medicines and herbal concoctions that can harm people's health (Fig 1.8). Biomedical science creates safe medicines that everyone can use without worrying about side effects and educates the public on medicine use.



A

Fig 1.8 (A) Herbal concoctions



B

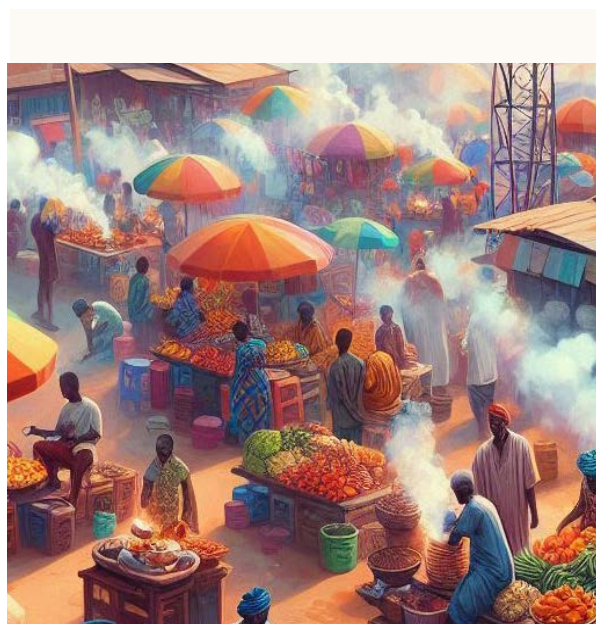
(B) safe medicines

2. Environmental pollution: Environmental pollution is a major concern that affects both our planet and our health (See Fig 1.9). Biomedical scientists develop methods like setting safe exposure limits, educating the public on environmental health, creating biodegradable materials for medical devices, and packaging to protect public health.



A

Fig 1.9 (A) Land pollution



B

(B) Air pollution

3. Failed organs or non-functioning body parts: When organs in our bodies fail to work properly or certain body parts stop functioning, it can be challenging for people. Biomedical scientists design and develop artificial organs to replace them (See Fig 1.10).



Fig 1.10 Artificial heart

4. **Nutrient deficiency disease:** When our bodies don't get enough essential nutrients, it can lead to what we call nutrient deficiency diseases. Nutritionists or dieticians provide assistance on the type of diet that can improve health.
5. **Wrong drug dosage:** Taking a wrong dosage of medication can be dangerous to our health. Biomedical scientists give health education on the importance of appropriate dosage of drugs to prevent overdose, underdose, and abuse of drugs.
6. **Contagious diseases:** These diseases, like mumps and 'apollo' (acute haemorrhagic conjunctivitis), can spread quickly (See Fig 1.11A). Biomedical scientists educate us on proper hygiene and transmission control measures (See Fig 1.11B).



A

Fig 1.11 (A) Apollo



B

(B) Hand washing

Other Biomedical Science-Related Issues or Problems Outside the Local Society that can be Addressed Through Biomedical Science.

1. Unfair healthcare access: This is a global issue that affects millions of people around the world. The world needs an increase in the number of biomedical professionals to ensure better access to quality healthcare.
2. Failed organs or non-functioning body parts: The organs in our bodies can fail to work properly or certain body parts may stop functioning. When this happens, biomedical professionals design and develop artificial organs to replace them.
3. Aging population: As our population ages, there is a growing need to address the unique health challenges faced by elderly individuals. Biomedical scientists and researchers develop technologies and medications to improve the quality of lives of elderly persons.

Activity 1 Identifying local health problems

1. Look around your community or school and identify some health problems that can be addressed by biomedical science.
2. How is biomedical science applied to solve these problems?
3. *Hint:* Consider what biomedical scientists can do to resolve such problems.
4. Share your observations and solutions with a friend or relative.

Activity 2 Problems outside your society

1. Surf the internet for other issues or problems outside your society that can be addressed through biomedical science.
2. *Hint:* Consider some infectious and chronic diseases.
3. Suggest how the problems can be solved with biomedical science
4. Share your experience with someone.

Extended Reading

- To read more on assistive devices and implants especially artificial heart, click [here](#)
- Click [here](#) for video on Barmes Global Health Lecture 2024.
- Visit the National Institutes of Health (NIH) website [here](#) to explore more on health issues

IDENTIFYING A LOCAL PROBLEM THAT COULD BE ADDRESSED THROUGH THE SCIENTIFIC METHOD, WITH A FOCUS ON THE HYPOTHESIS OF THE SCIENTIFIC METHOD

The scientific method is a systematic approach that scientists employ to explore and comprehend natural occurrences in our environment.

This method involves objectively verifying facts through experimentation and testing. The fundamental steps include observing a phenomenon, creating a hypothesis, predicting outcomes, performing experiments, analysing data, and drawing conclusions.

Steps of the Scientific Method in Biomedical Research

1. **Observation:** The first step involves observing a phenomenon or identifying a problem in biomedical science. This could be anything from a disease outbreak to a cellular process.
2. **Questioning:** Based on observations, scientists develop research questions that seek to explain the observed phenomena or to explore a particular aspect of the natural world.
3. **Formulating a Hypothesis:** Based on the observation, a hypothesis is formulated. A hypothesis is a testable prediction or explanation for the observed phenomenon.
4. **Prediction:** From the hypothesis, scientists make specific predictions about what they expect to observe if the hypothesis is true. These predictions are used to design experiments or gather further data.
5. **Experimentation or Data collection:** Experiments are designed and conducted to test the hypothesis. This could mean doing tests in a lab, using animals to study, or trying out the treatment on people in controlled studies.
6. **Data analysis:** The data collected from experiments are analysed to determine if they support or refute the hypothesis.
7. **Conclusion:** Based on the data analysis, a conclusion is drawn regarding the validity of the hypothesis. Further experiments may be conducted to confirm the findings.

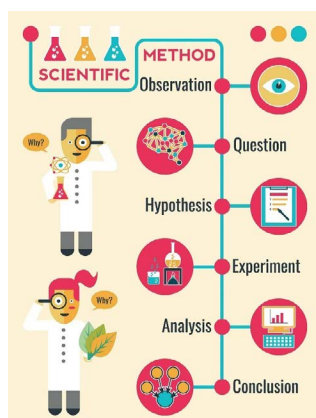


Fig 1.12 Steps of The Scientific Method

Problems such as malnutrition, loss of body function, poor sanitation, and the rising incidence of waterborne diseases, in a specific community due to contaminated drinking water sources, could be addressed using scientific methods (See **Table 1.1**).

Table 1.1 Example of an application of the scientific process in biomedical science

Observation	People in a certain area are getting sick more often from diseases like cholera, giardiasis, and typhoid fever. These sicknesses show up with symptoms like diarrhoea, throwing up, and having a fever, which usually means they're caused by dirty water.
Questioning	• What is the extent and nature of contamination in the drinking water sources within the specific community experiencing a rising incidence of waterborne diseases? • How effective is the selected water filtration and purification method in reducing the levels of harmful bacteria, viruses, and pathogens in the contaminated drinking water sources, and does using the cleaning method lower the number of people reporting sickness from water-related diseases in the community?
Hypothesis	If the drinking water in the community is contaminated with harmful bacteria or pathogens, then treating the water using a specific filtration and purification method will reduce the incidence of waterborne diseases among residents.
Prediction	The people getting sick from using dirty water suggests the possibility that the sickness is caused by harmful bacteria in the contaminated water source.
Experimentation	To determine what the exact condition is • Water samples from various sources within the community, including taps, wells, and reservoirs are collected. • A chosen water cleaning method on some of the collected water samples is tried out. • Maintain a control group of untreated water samples for comparison.
Data Analysis	After testing both the treated and untreated water samples in the laboratory, the results showed a substantial decrease in the presence of harmful bacteria, viruses, and other pathogens in the treated water samples compared to the untreated ones. This analysis confirms the effectiveness of the water treatment method in significantly reducing contamination levels and improving the safety of the drinking water in the community

Conclusion	After comparing the contamination levels and the number of waterborne disease cases before and after using the water treatment method, a significant improvement was found. The experimental data supported the initial hypothesis. It was concluded that treating the contaminated drinking water effectively reduced the risk of waterborne diseases in the community.
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Activity 1 Discussion on the scientific method

Form a group of five of your classmates and discuss.

- Identify a local problem in your community.
- Discuss how this problem could be addressed through the scientific method (your discussion should focus on the main steps of the scientific method).
- Share your ideas as you work with your group to address this problem in your community.

Self-reflection

Reflect on the group discussion. Did you correctly identify all the steps of the scientific method? What challenges did you encounter?

Activity 2 Experimental Designs

- 1 Design a simple experiment to investigate or analyse biomedical problems in society such as malnutrition, loss of body function, and poor sanitation, using the scientific method.
- 2 Outline the steps of the scientific method you would follow in your experiment (you may refer to Table 1.1).

Self-reflection

Evaluate your experimental design. Does it incorporate all the necessary steps of the scientific method? How would you improve your experiment?

REVIEW QUESTIONS 1

REVIEW QUESTIONS 1.1

1. Answer TRUE or FALSE

- a. Biomedical science focuses on understanding how the human body works.
- b. Biomedical scientists focus on how diseases develop and how they can be treated and prevented.
- c. Biomedical science is a purely biological science.

2. How does Biomedical Science differ from other pure sciences?

3. Describe the role of a biomedical scientist.

4. Scenario:

Eli, a 15-year-old student, wakes up one morning feeling unwell. He has a high fever, chills, general feeling of discomfort, nausea and vomiting with abdominal pain. He also feels very tired and has a headache. Eli's mother is worried and decides to take him to the doctor. It was discovered that Eli had malaria.

- a. What type of biomedical science product was used for diagnosing Eli's condition?
 - b. Which biomedical science product could be used to help treat Eli's symptoms?
- ### 5. Why is it important for biomedical scientists to have good communication skills?
- ### 6. From your knowledge of what biomedical science is, discuss two misconceptions of biomedical science in our society and justify why they are misconceptions.

REVIEW QUESTIONS 1.2

- ### 1. State at least three biomedical science-related problems in society.
- ### 2. Analyse three biomedical science-related challenge in your locality and use the knowledge acquired in Biomedical Science to propose a solution.

REVIEW QUESTIONS 1.3

- ### 1. What is the scientific method?
- ### 2. Describe the steps involved in the scientific method.
- ### 3. Why is the scientific method important in biomedical science?

Extended Reading:

1. Understanding the Scientific Method: A Guide for Biomedical Researchers. <https://www.jblearning.com/catalog/productdetails/9781284197563>
2. The Role of Hypothesis Testing in Biomedical Science. <https://books.google.com.gh/books?id=0qw4DwAAQBAJ&printsec=frontcover#v=onepage&q&f=false>
3. Importance of Reproducibility in Biomedical Research. <https://www.sciencedirect.com/science/article/abs/pii/S0169409X22000084>

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- Resnik, D. B., & Shamoo, A. E. (2017). Reproducibility and research integrity. *Accountability in research*, 24(2), 116-123.
- Figure 1: The steps of the scientific method: <https://www.shutterstock.com/image-vector/scientific-method-vector-illustration-labeled-process-1753903823>

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