

Payam Noor University

Special language for microbiology

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امروز کتابخوانی و علم‌آموزی نه تنها یک وظیفه‌ی ملی، که یک واجب دینی است!

مقام معظم رهبری

در عصر حاضر یکی از شاخصه‌های ارزیابی رشد، توسعه و پیشرفت فرهنگی هر کشوری میزان تولید کتاب، مطالعه و کتاب‌خوانی مردم آن مرز و بوم است. ایران اسلامی نیز از دیرباز تاکنون با داشتن تمدنی چندهزارساله و مراکز متعدد علمی، فرهنگی، کتابخانه‌های معتبر، علما و دانشمندان بزرگ با آثار ارزشمند تاریخی، سرآمد دولت‌ها و ملت‌های دیگر بوده و در عرصه فرهنگ و تمدن جهانی به‌سان خورشیدی تابناک همچنان می‌درخشد و با فرزندان نیک‌نهاد خویش هنرنمایی می‌کند. چه کسی است که در دنیا با دانشمندان فرزانه و نام‌آور ایرانی همچون ابوعلی سینا، ابوریحان بیرونی، فارابی، خوارزمی و ... همچنین شاعران برجسته‌ای نظیر فردوسی، سعدی، مولوی، حافظ و ... آشنا نباشد و در مقابل عظمت آنها سر تعظیم فرود نیاورد. تمامی این افتخارات ارزشمند، برگرفته از میزان عشق و علاقه فراوان ملت ما به فراگیری علم و دانش از طریق خواندن و مطالعه منابع و کتاب‌های گوناگون است. به شکرانه الهی، تاریخ و گذشته ما، همیشه درخشان و پر بار است. ولی اکنون در این زمینه در چه جایگاهی قرار داریم؟ آمار و ارقام ارائه‌شده از سوی مجامع و سازمان‌های فرهنگی در مورد سرانه مطالعه هر ایرانی، برایمان چندان امیدوارکننده نمی‌باشد.

کتاب، دروازه‌ای به سوی گستره دانش و معرفت است و کتاب خوب، یکی از بهترین ابزارهای کمال بشری است. همه دستاوردهای بشر در سراسر عمر جهان، تا آنجا که قابل کتابت بوده است، در میان دست‌نوشته‌هایی است که انسان‌ها پدید آورده و می‌آورند. در این مجموعه بی‌نظیر، تعالیم الهی، درس‌های پیامبران به بشر، و همچنین علوم مختلفی است که سعادت بشر بدون آگاهی از آنها امکان‌پذیر نیست. کسی که با دنیای زیبا و زندگی‌بخش کتاب ارتباط ندارد بی‌شک از مهم‌ترین دستاورد انسانی و نیز از بیشترین معارف الهی و بشری محروم است. با این دیدگاه، به‌روشنی می‌توان ارزش و مفهوم رمزی عمیق در این حقیقت تاریخی را دریافت که اولین خطاب خداوند متعال به پیامبر گرامی اسلام (ص) این است که «بخوان!» و در اولین سوره‌ای که بر آن فرستاده عظیم‌الشان خداوند، فرود آمده، نام «قلم» به تجلیل یاد

شده است: «إِقْرَأْ وَرَبُّكَ الْأَكْرَمُ. الَّذِي عَلَّمَ بِالْقَلَمِ» در اهمیت عنصر کتاب برای تکامل جامعه انسانی، همین بس که تمامی ادیان آسمانی و رجال بزرگ تاریخ بشری، از طریق کتاب جاودانه مانده‌اند.

دانشگاه پیام‌نور با گستره جغرافیایی ایران شمول خود با هدف آموزش برای همه، همه‌جا و همه‌وقت، به‌عنوان دانشگاهی کتاب‌محور در نظام آموزش عالی کشورمان، افتخار دارد جایگاه اندیشه‌سازی و خردورزی بخش عظیمی از جوانان جویای علم این مرز و بوم باشد. تلاش فراوانی در ایام طولانی فعالیت این دانشگاه انجام پذیرفته تا با بهره‌گیری از تجربه‌های گرانقدر استادان و صاحب‌نظران برجسته کشورمان، کتاب‌ها و منابع آموزشی درسی شاخص و خودآموز تولید شود. در آینده هم، این مهم با هدف ارتقای سطح علمی، روزآمدی و توجه بیشتر به نیازهای مخاطبان دانشگاه پیام‌نور با جدیت ادامه خواهد داشت. به‌طور قطع استفاده از نظرات استادان، صاحب‌نظران و دانشجویان محترم، ما را در انجام این وظیفه مهم و خطیر یاری‌رسان خواهد بود. پیشاپیش از تمامی عزیزانی که با نقد، تصحیح و پیشنهادهای خود ما را در انجام این وظیفه خطیر یاری می‌رسانند، سپاسگزاری می‌نماییم. لازم است از تمامی اندیشمندانی که تاکنون دانشگاه پیام‌نور را منزلگه اندیشه‌سازی خود دانسته و ما را در تولید کتاب و محتوای آموزشی درسی یاری نموده‌اند، صمیمانه قدردانی گردد. موفقیت و بهروزی تمامی دانشجویان و دانش‌پژوهان عزیز آرزوی همیشگی ما است.

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پیشگفتار مولفین

از آنجا که دانشجویان کارشناسی زیست‌شناسی - گرایش میکروبیولوژی به منبع مشخصی برای درس متون تخصصی میکروبیولوژی دسترسی نداشتند، سعی شد با نگارش این کتاب؛ به این نیاز پاسخ داده شود. کتاب پیش‌رو برای درس متون تخصصی میکروبیولوژی این دانشجویان، که دو واحد می‌باشد، تهیه و تدوین شده است. یادآوری این نکته مهم است که گستره دانش میکروبیولوژی بسیار پهناور و سیر پیشرفت آن شگفت‌انگیز است و به همین خاطر؛ نمی‌توان همه اصطلاحات آن را در قالب یک کتاب خاص، گردآوری و تدوین کرد. با این وجود هدف ما آن بود تا دانشجویان و خوانندگان گرامی ضمن یادگیری تعدادی از واژگان پرکاربرد در دنیای میکروبیولوژی؛ با فنون ترجمه، درک مطلب و خلاصه‌نویسی متون تخصصی میکروبیولوژی آشنا شوند.

تلاش شده محتوای کتاب بر اساس سرفصل مصوب وزارت علوم تحقیقات و فناوری تنظیم و شیوه‌ی نگارش آن به صورت خودآموز باشد؛ تا ضمن پوشش نیاز دانشجویان عزیز، یادگیری مستقل مطالب برای دانشجویان امکان‌پذیر و دسترسی به پاسخ پرسش‌ها آسان باشد. به منظور یادگیری هرچه بهتر واژه‌ها و مفاهیم تخصصی، هر واژه یا اصطلاح در چند موقعیت متفاوت به کار برده شده است. همچنین علاوه بر ارائه واژه‌نامه و معانی هر واژه در انتهای کتاب؛ تلفظ هر واژه بر مبنای فونتیک آکسفوردی در کتاب گنجانده شده تا تلفظ درست آنها در دسترس باشد.

امیدواریم با تدوین این اثر، به بخشی از نیاز دانشجویان گرامی کارشناسی میکروبیولوژی پاسخ دهیم. گرچه تلاش ما بر آن بود تا کتابی مناسب تهیه و تالیف شود، اما قطعاً این اثر خالی از کاستی نیست. بدین روی از همه اساتید، دانشجویان و خوانندگان گرانقدر درخواست داریم تا با پیشنهادات خود، ما را در بهبود کیفیت این اثر یاری رسانند. پیشاپیش مراتب سپاسگزاری خود را از نظرات ارزشمند سروران اعلام می‌نماییم.

با فروتنی: مولفین

Unit 1

Introduction to Microbiology

آنچه در این فصل خواهیم آموخت:

Vocabulary

۱. واژگان

چند واژه کاربردی در مورد آشنایی با مفاهیم میکروبیولوژی پایه ارائه و مفهوم آنها تعریف شده است. تلاش کنید با خواندن تعریف هر واژه، معنی آن را حدس بزنید. هر کدام از این واژه‌ها در یک جمله به کار رفته است تا مفهوم آن بهتر درک شود.

Pronunciation

۲. تلفظ

در این بخش چند واژه به همراه فونتیک آکسفوردی آنها داده شده که باید تلفظ صحیح آنها را یاد گرفته و در جلسهٔ مروری، با کمک مدرس از تلفظ درست آنها اطمینان حاصل نمایید.

Passages

۳. متن‌ها

در این قسمت چهار متن در مورد تاریخچه و دنیای میکروبیولوژی شده که بایستی آنها را خوانده و مفهوم آنها را درک نمایید، به شکلی که بتوانید به سوالات مستخرج از هر متن؛ پاسخ دهید. برای درک بهتر متن‌ها، شکل‌هایی ارائه شده که توصیه می‌شود آنها را مورد توجه قرار دهید.

Exercises

۴. تمرین‌ها

در این بخش، بر اساس واژه‌ها و متن‌هایی که ارائه شده است؛ تمرین‌های مختلفی طرح شده که ضمن سنجش میزان یادگیری، کمک خواهد کرد تا مهارت دانشجو در درک بهتر متون تخصصی میکروبیولوژی افزایش یابد. این تمرین‌ها شامل موارد زیر است: ۱. سوالات درک مطلب (Comprehension questions): که بایستی با جملات کوتاه و گویا بدانها پاسخ داده شود. ۲. عبارات درست یا نادرست (True and false statements): که بایستی درست یا غلط بودن

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مفهوم آن، پاسخ داده شود. ۳. مهارت‌های ساختاری و گرامری (Structure and Grammar drills):
که بایستی به پرسش‌های گرامری و دستوری طرح شده، پاسخ داده شود. ۴. خلاصه‌نویسی (Summary): که بایستی چکیده‌ی یک از متن‌ها داده شده را با استفاده از دامنه‌ی واژگان خود، به صورت خلاصه بازنویسی کنید. ۵. ترجمه از انگلیسی به فارسی (Translate from English into Persian): که بایستی متن داده شده را از انگلیسی به فارسی ترجمه کنید. ۶. ترجمه از فارسی به انگلیسی (Translate from Persian into English): که بایستی متن داده شده را از فارسی به انگلیسی ترجمه کنید. ۷. جمله‌سازی (Words and phrases): که بایستی واژه‌ها یا عبارت‌های داده شده را در جمله به کار ببرید.

Key to exercises and questions

۵. کلید یا پاسخ سوالات

در این قسمت، پاسخ یا کلید تمرین‌های فصل داده شده است تا با تطبیق پاسخ‌های خود با آنها؛ میزان یادگیری خود را بسنجید.

Part I. Vocabulary

Microbiological terminology

Observe the following words. Can you guess their meaning from the definition and examples given?

Vocabulary

Archaea: Archaea are prokaryotic microorganisms that differ from bacteria and are known to survive in extreme environments such as hot springs and deep-sea vents.

Archaea have unique biochemical and genetic properties that bring them closer to eukaryotes in some aspects.

Microbiology: Microbiology is the study of microscopic organisms, such as bacteria, viruses, fungi and protozoa.

Microbiology helps us understand and combat diseases caused by microorganisms.

Microorganism: A microorganism is an organism of microscopic size, which may exist in its single-celled form or as a colony of cells.

Microorganisms are useful in the production of foods, wastewater treatment, the production of biofuels and a wide range of chemicals and enzymes.

Microscope: A microscope is an instrument used to magnify and observe objects that are too small to be seen clearly with the naked eye. A microscope is a powerful tool that reveals the intricate details of microorganisms.

Bacteria: Bacteria are single-celled prokaryotic microorganisms that lack a nucleus and thrive in different environments.

Bacteria are essential to ecosystems, industry and human health. They can be both helpful and harmful.

Colony: In biology, a colony refers to a group of organisms of the same species that live closely together, often for mutual benefit. This can include groups of bacteria, insects (such as ants or bees) or plants growing from the same root system.

The formation of visible colonies makes it easier to see and grow microorganisms.

Prokaryote: A prokaryote is a single-celled organism whose cell lacks a nucleus and other membrane-bound organelles.

Prokaryotes are divided into two distinct groups: the bacteria and the archaea, which scientists believe have unique evolutionary lineages.

Eukaryote: Any cell or organism that possesses a clearly defined nucleus. The eukaryotic cell has a nuclear membrane that surrounds the nucleus. Eukaryotic cells also contain various organelles, including mitochondria, Golgi apparatus, the endoplasmic reticulum, lysosomes, etc.

A eukaryote is any organism whose cells contain a nucleus, such as plants, animals and fungi.

Cell Membrane: All cells have a permeability barrier, the cell membrane or cytoplasmic membrane, which separates the inside of the cell from the outside world.

The cell membrane controls the movement of substances in and out of the cell, as it is selectively permeable to ions and organic molecules.

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Cell Wall: The cell wall is a relatively permeable structure located outside the cell membrane and is a much stronger layer than the membrane itself.

Plant cells and most microorganisms have cell walls, whereas animal cells typically do not.

Biomass: Biomass is the term used to describe material derived from recently living organisms that is used to produce bioenergy. Examples of biomass include wood, wood residues, energy crops, agricultural residues and organic waste from households and industry.

Part II. Pronunciation practice

Try to learn the correct pronunciation of each term based on the phonetics provided. In the review sessions, repeat after the teacher.

1. Biomass /'baɪəʊ,mæs/
2. Cell membrane—/sɛl 'mɛm.breɪn/
3. Cell wall /sɛl wɔ:l/
4. Colony /'kɒ.lə.ni/
5. Eukaryote /ju:'kɛr.i.oʊt/or/ju:'kær.i.ət/
6. Microorganism /,maɪ.krəʊ'ɔ:r.gə.nɪ.zəm/
7. Microscope /'maɪ.krə.skəʊp/
8. Multicellular /,mʌl.ti'sɛl.jə.lə-/
9. Pathogen /'pæ.θə.dʒən/
10. Prokaryote /prəʊ'kɛr.i.oʊt/or/prəʊ'kær.i.ət/

Part III. Passages

Four texts have been provided in this section and after each text, several questions have been given to enhance your understanding and assess your learning. Read them text carefully and answer their following questions. In the review session, please check your answers with your teacher.

1. The Microbial World

Microorganisms are life forms that are too small to be seen with the naked human eye. These microscopic organisms are diverse in form and work and inhabit every environment on earth where life is possible. Many microbes are undifferentiated single-celled organisms, but some can form complex structures and some are even multi-celled. Microorganisms usually live in complex microbial communities and their activities are regulated by interactions with each other, with their environment and with other organisms. The science of microbiology is all about microorganisms, who they are, how they act and what they do. Microorganisms have been teeming on land and in the oceans for billions of years before plants and animals existed and their diversity is staggering. Microorganisms play a substantial role in sustaining life on Earth and, therefore, in the production of the Earth's total biomass. In fact, the oxygen (O₂) we breathe is the result of microbial activity (remember that plants also play a significant role in oxygen production). Plants and animals are immersed in a world of microbes, and microbial activity, symbioses and pathogens have strongly influenced their evolution and survival. Microorganisms are integrated into human life, from infectious diseases to the food we eat, the water we drink, the fertility of our soils, the health of our animals and even the fuel we put in our cars. Microbiology is concerned with the predominant form of life on Earth and the impact that microbes have on our planet and all the creatures that call it home.

Questions Part III. 1. Based on the above text, answer the following questions.

1. What are microorganisms?
 - a) Large organisms visible to the naked eye
 - b) Life forms too small to be seen with the naked human eye
 - c) Only harmful bacteria and viruses
 - d) Exclusively single-celled organisms

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2. Where can microorganisms be found?
 - a) Only in water
 - b) Only in soil
 - c) In every environment on earth where life is possible
 - d) Only inside living organisms
3. What do microorganisms primarily form in nature?
 - a) Single isolated colonies
 - b) Simple, independent cells
 - c) Complex microbial communities
 - d) Only parasitic relationships
4. What is microbiology?
 - a) The study of bacteria only
 - b) The study of microorganisms and their roles in life
 - c) The study of plants and animals
 - d) The study of infectious diseases only
5. How do microorganisms contribute to Earth's biomass?
 - a) They form a minor fraction of Earth's biomass
 - b) They make up a large fraction of Earth's biomass
 - c) They contribute only through decomposition
 - d) They do not contribute to biomass
6. Which gas essential for life is produced by microorganisms?
 - a) Carbon dioxide (CO₂)
 - b) Oxygen (O₂)
 - c) Nitrogen (N₂)
 - d) Hydrogen (H₂)
7. How have microorganisms influenced the evolution of plants and animals?
 - a) By competing with them for resources
 - b) By forming symbiotic relationships and causing diseases
 - c) By eliminating weaker species
 - d) By only acting as decomposers

8. What role do microorganisms play in human life?
- a) They are only responsible for causing diseases
 - b) They contribute to food, water, soil fertility and even fuel production
 - c) They are only used in laboratories for research
 - d) They have no impact on human activities
9. Which of the following statements is true about microbes?
- a) Many microbes are undifferentiated single-celled organisms.
 - b) All microbes are multicelled organisms.
 - c) No microbes can form complex structures.
 - d) Microbes are only found in multicelled forms.
10. What is the relationship between microorganisms and diseases?
- a) All microorganisms cause diseases
 - b) Viruses and fungi are the only disease-causing microbes
 - c) Only bacteria can cause diseases
 - d) Some microorganisms, known as pathogens, cause diseases

2. History of Microbiology

The science of microbiology has progressed considerably over time thanks to technological advances, in particular the microscope, which is the most important instrument for analysing microorganisms. The field emerged with the invention of the microscope, which enabled the discovery of tiny organisms that had previously only been speculated about but could not be seen with the naked eye. Robert Hooke, an early microscopist, provided the first images of microorganisms (Fig. 1.1). Antoni van Leeuwenhoek, another key figure, is considered to be the first to observe bacteria through his handmade single-lens microscopes. In the 19th century, Louis Pasteur and Robert Koch advanced microbiology with their work on germ theory (the germ theory of disease, states that microorganisms known as pathogens or "germs" can cause disease), fermentation and inoculation. In addition to microscopy, microbiology today includes molecular biology and genetic sequencing, which have deepened our understanding of the role of

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microbes in health, disease, agriculture and much more. Today, advances in DNA sequencing and genomics have given us further insight into microbial diversity and evolution, making microbiology a dynamic and constantly evolving field.

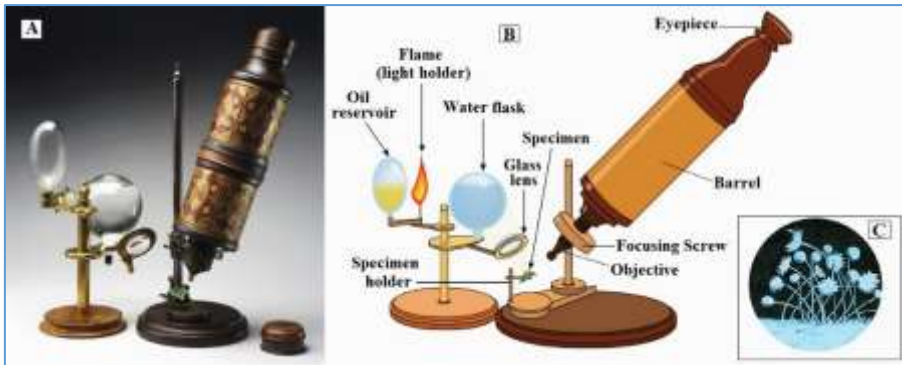


Figure 1.1. Robert Hooke's early microscope (1670). A: the actual image B: the schematic drawing and C): the first published depiction of a microorganism provided by Hooke, a "hairy mold" colony which microbiologists have subsequently identified as *Mucor*.

Questions Part III. 2. Based on the above text, answer the following questions.

1. What instrument is described as the most important for analyzing microorganisms?
 - a) Telescope
 - b) PCR machine
 - c) Microscope
 - d) Centrifuge
2. Who provided the first images of microorganisms?
 - a) Louis Pasteur
 - b) Robert Hooke
 - c) Antoni van Leeuwenhoek
 - d) Charles Darwin
3. Which two figures are credited in the text with advancing microbiology in the 19th century through work on germ theory, fermentation, and inoculation?
 - a) Pasteur and Koch
 - b) Darwin and Linnaeus
 - c) Watson and Crick
 - d) Franklin and Babcock

4. What does the germ theory of disease state, as described in the text?
 - a) Diseases are caused by microbial agents
 - b) Diseases are caused by genetic defects
 - c) Diseases are solely due to environmental factors
 - d) Diseases are transmitted only by viruses
5. Beyond microscopy, which modern disciplines have deepened our understanding of microbes according to the text?
 - a) Plant physiology and biochemistry
 - b) Classical physics and thermodynamics
 - c) Molecular biology and genetic sequencing
 - d) Soil science and hydrology
6. What have advances in DNA sequencing and genomics contributed to, as stated in the passage?
 - a) A diminished interest in microbial diversity
 - b) The exclusion of microbes from health research
 - c) The complete replacement of microscopy
 - d) A deeper understanding of microbial diversity and evolution

3. The Scope of Microbiology

Microbiology is a broad field that encompasses the study of microorganisms, including bacteria, viruses, fungi, algae and protozoa. It is a multidisciplinary field that overlaps with other scientific fields, such as medicine, agriculture, environmental sciences and biotechnology.

Medical microbiology is one of its core areas, dealing with the role of microorganisms in human and animal health, in particular the identification and treatment of infectious diseases caused by pathogenic microbes. Medical microbiology deals with the diagnosis, prevention and treatment of microbial infections in humans.

Another important area, environmental microbiology, studies the ecological role of microorganisms in the natural environment, including their impact on the quality of soil, water and air. This field also looks at how microbes contribute to biogeochemical cycles and environmental sustainability.

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Industrial microbiology applies microbial processes to the production of goods such as food, beverages, pharmaceuticals and biofuels.

Agricultural microbiology focuses on the relationship between microbes and plants, including plant diseases, soil fertility and plant growth promotion.

Microbial genetics and molecular biology provide insights into the genetic makeup of microorganisms and enable the study of their molecular mechanisms, behaviors and interactions with other organisms.

Microbiology plays a crucial role in the development of vaccines, antibiotics and other therapeutic agents, as well as in biotechnological innovations. With its applications in various sectors, microbiology is a constantly evolving field that continues to shape scientific progress and technological advances.

Questions Part III. 3. Based on the above text, answer the following questions.

1. What does microbiology study?
 - a) Only bacteria
 - b) Only viruses
 - c) Microorganisms, including bacteria, viruses, fungi, algae and protozoa
 - d) Only infectious diseases
2. How does microbiology intersect with other scientific fields?
 - a) It is limited to medicine only
 - b) It has applications in medicine, agriculture, environmental science and biotechnology
 - c) It only deals with laboratory research
 - d) It does not relate to any other scientific fields
3. What is the focus of medical microbiology?
 - a) Studying plant-microbe interactions
 - b) Examining the structure of microorganisms

- c) Identifying and treating infectious diseases in humans and animals
 - d) Studying microbes in soil and water
4. Environmental microbiology mainly studies:
- a) Microbial roles in soil, water and air quality
 - b) Microbial infections in humans
 - c) The production of antibiotics
 - d) Genetic sequencing of microorganisms
5. What does industrial microbiology focus on?
- a) The study of microbe-driven environmental sustainability
 - b) The production of food, beverages, pharmaceuticals and biofuels using microbial processes
 - c) Diagnosing infectious diseases
 - d) The impact of microbes on plant diseases
6. How does agricultural microbiology contribute to plant health?
- a) By studying plant diseases, soil fertility and plant growth promotion
 - b) By finding new ways to eliminate all microbes from soil
 - c) By focusing only on fungi
 - d) By studying the anatomy of plants
7. What is the significance of microbial genetics?
- a) They help in understanding the genetic makeup of microorganisms
 - b) They are only used for virus identification
 - c) They do not contribute to microbiology
 - d) They focus solely on human genetics
8. How does microbiology contribute to medicine?
- a) It helps develop vaccines, antibiotics and other therapeutic agents
 - b) It only focuses on bacterial infections
 - c) It does not contribute to medicine
 - d) It only studies viruses
9. What role does microbiology play in biotechnology?
- a) It does not play any role in biotechnology
 - b) It helps in developing biotechnological innovations using microbes
 - c) It only studies diseases
 - d) It is limited to environmental science

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10. Why is microbiology considered an ever-evolving field?

- a) Because it is no longer relevant to science
- b) Because microbes constantly evolve and new discoveries are made in genetics, medicine and biotechnology
- c) Because it has remained unchanged for centuries
- d) Because it only studies past discoveries

4. The Fascinating World of Bacteria

Bacteria are among the most abundant and diverse microorganisms on earth and play a crucial role in ecosystems and human health. As single-celled organisms, they contribute significantly to the planet's biomass and thrive in extreme environments such as deep-sea hydrothermal vents, acidic hot springs and even the human body. Bacteria are classified as prokaryotes, meaning they do not have a membrane-bound nucleus, unlike eukaryotes, which have a defined nucleus and complex organelles (Fig. 1.2). The structural integrity of bacterial cells is maintained by the cell wall. It is a rigid layer that provides protection and shape. The cell membrane regulates the exchange of nutrients and waste products and ensures survival under different environmental conditions. Bacteria often exist in groups called colonies, in which the individual cells function collectively and sometimes perform specific tasks. These colonies can be beneficial, as in the case of fermentation and nitrogen fixation, or harmful, as in the case of pathogenic bacteria responsible for disease. Despite their microscopic size, bacteria have a profound impact on life and influence ecosystems, industry and medicine.

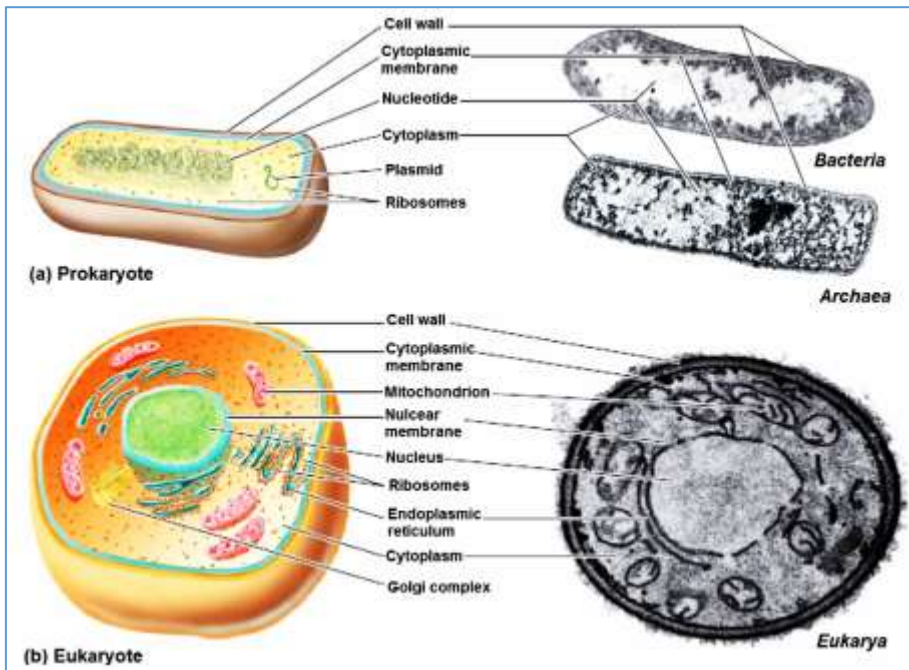


Figure 1.2. Microbial cell structure. (a) (Left) Diagram of a prokaryotic cell. (Right) Electron micrograph of *Heliobacterium modesticaldum* (bacteria, cell approx. 1-5 μm in diameter) and *Thermoproteus neutrophilus* (archaea, cell approx. 0.5-2 μm in diameter). (b) (Left) Schematic of a eukaryotic cell. (Right) Electron micrograph of a *Saccharomyces cerevisiae* cell (Eukarya, cell has a diameter of approx. 10-100 μm).

Questions Part III. 4. Based on the above text, answer the following questions.

1. What is one of the main roles of bacteria in ecosystems?
 - a) Producing oxygen
 - b) Storing genetic material
 - c) Converting sunlight into energy
 - d) Influencing human health
2. Which of the following environments can bacteria thrive in?

a) Only in freshwater lakes	b) Deep-sea hydrothermal vents
c) The vacuum of space	d) Only in soil