***УДК 002.304***

***Верюханова О.П.,***
***доцент,***
***доцент кафедры «иностранных языков и профессиональной коммуникации»***
***ФГАОУ ВО «Белгородский государственный национальный исследовательский университет».***
***Россия, г. Белгород***
***Малиева А.Н.,***
***студент,***
***1 курс, факультет «Биология»***
***Институт Фармации Химии и Биологии***
***Россия, г. Белгород***

# РОСТ И РАЗМНОЖЕНИЕ МИКРООРГАНИЗМОВ: КЛЮЧЕВЫЕ МЕХАНИЗМЫ, УСЛОВИЯ И КУЛЬТУРАЛЬНЫЕ ПРОЯВЛЕНИЯ

***Аннотация:*** *В статье рассматриваются фундаментальные процессы роста и размножения микроорганизмов, их различия и взаимосвязь. Описаны основные способы деления прокариот: бинарное деление перетяжкой и с образованием поперечной перегородки, а также почкование, фрагментация и спорообразование. Проанализированы ключевые факторы внешней среды, влияющие на скорость роста микробов: температура, pH, кислород, осмотическое давление и наличие питательных веществ. Представлены фазы развития бактериальной популяции в периодической культуре: лаг-фаза, логарифмическая, стационарная и фаза отмирания. Описаны культуральные свойства микроорганизмов на плотных и жидких питательных средах, включая морфологию колоний и характер роста. Особое внимание уделено энергетическому обмену (дыхание и брожение) и роли ферментов в белковом и углеводном обмене бактерий. Понимание этих*

*закономерностей имеет важное значение для микробиологической диагностики, биотехнологии, пищевой промышленности и ветеринарной медицины.*

***Ключевые слова:*** *Рост бактерий, бинарное деление, фазы роста, S- и R-колонии, питательные среды, факторы роста, температура и pH, аэробы и анаэробы, дыхание и брожение, эффект Пастера.*

***Verkhukhova O.P.,***
***Associate Professor***
***Associate Professor of the Department of "Foreign Languages and Professional Communication"***
***Belgorod State National Research University***
***Belgorod, Russia***
***Malieva A.N.,***
***Student***
***1st year, Faculty of "Biology"***
***Institute of Pharmacy, Chemistry and Biology***
***Belgorod, Russia***

# GROWTH AND REPRODUCTION OF MICROORGANISMS: KEY MECHANISMS, CONDITIONS, AND CULTURAL MANIFESTATIONS

***Annotation:*** *The article examines the fundamental processes of growth and reproduction of microorganisms, their differences and interrelation. The main methods of prokaryotic division are described: binary fission by constriction and by transverse septum formation, as well as budding, fragmentation, and sporulation. The key environmental factors affecting the rate of microbial growth are analyzed: temperature, pH, oxygen, osmotic pressure, and nutrient availability. The phases of bacterial population development in batch culture are presented: lag phase, logarithmic (exponential) phase, stationary phase, and death phase. The cultural*

*properties of microorganisms on solid and liquid nutrient media, including colony morphology and growth patterns, are described. Special attention is paid to energy metabolism (respiration and fermentation) and the role of enzymes in protein and carbohydrate metabolism of bacteria. Understanding these patterns is essential for microbiological diagnostics, biotechnology, food industry, and veterinary medicine.*

***Key words:*** *Bacterial growth, binary fission, growth phases, S- and R-colonies, culture media, growth factors, temperature and pH, aerobes and anaerobes, respiration and fermentation, Pasteur effect.*

## Why It Matters

Even though microbes are invisible to the naked eye, they follow the same biological rules as any other living thing on the planet: they need to eat and reproduce. Without these two processes, there would be no evolution or survival of entire populations of bacteria and fungi. For humans, this knowledge is the foundation of everything — from treating infections to making yogurt or producing antibiotics. If we understand how microorganisms gain mass and increase their numbers, we can either help beneficial species or stop dangerous pathogens [1,6].

## Growth vs. Reproduction — What's the Difference?

Let's clarify right away: for a microbiologist, "growth" and "reproduction" are not the same thing. Growth is when a cell gets bigger and heavier, synthesizing proteins, fats, DNA, and other essential substances. This continues until the cell becomes large and mature enough. Reproduction, on the other hand, is when the number of individuals in a population increases. In bacteria (prokaryotes), this usually happens through binary fission: one mother cell becomes two daughters, and they are almost like clones [5,9].

Here's an interesting fact: sometimes a cell grows but is in no hurry to divide — for example, when conditions are poor. In that case, it simply stores up fat or glycogen for later [2,7].

## How Exactly Do Prokaryotes Divide?

The most common types of binary fission look like this:

By constriction (favored by Gram-negative bacteria). The cell gradually narrows in the middle, like an hourglass, and then splits into two halves [4,10].

By forming a cross-wall (typical of Gram-positive species). A new wall is synthesized inside the cell, cutting the cytoplasm in two [3,7].

Some organisms can bud — this is when the daughter doesn't just separate but first grows as a little "bump" on the mother cell (some bacteria and yeasts do this). And in filamentous forms like actinomycetes, you see fragmentation of hyphae or spore formation.

## What Determines How Fast Microbes Reproduce?

The rate of division depends on a whole set of factors:

Food — sources of carbon, nitrogen, phosphorus, sulfur, and trace elements. Some bacteria (autotrophs) make their own organic matter from inorganic compounds; others (heterotrophs) prefer ready-made meals [6,10].

Temperature — psychrophiles like cold (up to +20°C), mesophiles prefer warmth (+20…+45°C, and this group includes most disease-causing agents), while thermophiles love heat (up to +95°C in hot springs).

Acidity (pH) — most bacteria prefer a neutral environment (pH around 7), but fungi like things a bit more acidic.

Oxygen — aerobes can't live without it, anaerobes find it harmful, and facultative anaerobes can go either way — switching between respiration and fermentation.

Salinity — many bacteria are quite tolerant of changes in osmotic pressure.

## How Does a Bacterial Population Behave in Liquid Medium?

If you put bacteria into a liquid broth and watch them over time, you can see a clear sequence of phases:

Lag phase — settling in and adapting. Cells grow but are in no rush to divide.

Logarithmic (exponential) phase — this is where the fun happens: division is at its maximum, and the population doubles at regular intervals (generation time).

Stationary phase — the number of newborns balances the number of deaths. Food is running out, and toxic waste products are building up [1,9].

Death phase — deaths start to outnumber births.

These phases are critical knowledge for anyone growing microbes on an industrial scale — for example, to produce enzymes or antibiotics.

What Microbes Look Like on Solid and Liquid Media

On a solid surface (like an agar plate in a Petri dish), bacteria form colonies — visible clusters of descendants that all came from a single cell. Colonies come in all sorts of varieties:

Size (pinpoint, small, large)

Shape (round, root-like, amoeba-like)

Edge (smooth, wavy, lobed, fringed)

Surface (smooth — S-form, rough — R-form)

Color (depends on pigments)

Consistency (buttery, dry, slimy, membrane-like)

In liquid media, things look different: growth can appear as uniform cloudiness, a sediment at the bottom, flakes clinging to the walls, or a film on the surface (especially with aerobes) [4,10].

Where Do Microbes Get the Energy for Growth and Division?

Any kind of growth and reproduction requires energy. Heterotrophs get it either by oxidizing organic compounds (respiration) or by fermenting them (alcoholic, lactic acid, butyric acid fermentation). Aerobes need oxygen for this; anaerobes use other electron acceptors. There's also the Pasteur effect: if oxygen appears, fermentation switches to respiration — which is much more efficient in terms of energy.

Protein metabolism in bacteria is also interesting: they not only synthesize their own amino acids but also break down foreign proteins using proteases. If the process happens without oxygen — that's putrefaction; if with oxygen — it's decay [2,7].

In Conclusion

Growth and reproduction in microbes are complex, tightly regulated mechanisms that depend both on the cell's own genetics and on what's happening in

the environment. Studying how fast a population grows, what phases it goes through, and what kind of colonies it forms — this is the basis for identifying microorganisms, diagnosing infectious diseases, checking food quality, and a whole bunch of biotechnological processes. By understanding these fundamentals, we can not only explain microbial behavior but also predict it — whether in nature or inside a sick patient's body [4,8].

**Использованные источники:**


1. Artamonova, M.N. Medical Microbiology, Virology and Immunology / M.N. Artamonova. — Moscow: GEOTAR-Media, 2021.
2. Gosmanov, R.G. Microbiology / R.G. Gosmanov. — St. Petersburg: Lan, 2021.
3. Emtsev, V.T., & Mishustin, E.N. Microbiology / V.T. Emtsev, E.N. Mishustin. — Moscow: Drofa, 2025.
4. Emtsev, V.T., & Mishustin, E.N. Microbiology / V.T. Emtsev, E.N. Mishustin. — Moscow: Drofa, 2025 (replacement for I.L. Rabotnova).
5. Zaripova, F.F., & Naumova, A.V. Laboratory Manual for Fundamentals of Microbiology / F.F. Zaripova, A.V. Naumova. — Kazan: KFU, 2025.
6. Zemskov, A.M. Fundamentals of Microbiology and Immunology / A.M. Zemskov. — Moscow: GEOTAR-Media, 2025.
7. Kolychev, N.M., & Gosmanov, R.G. Veterinary Microbiology and Mycology / N.M. Kolychev, R.G. Gosmanov. — St. Petersburg: Lan, 2024.
8. Kolychev, N.M., & Gosmanov, R.G. Veterinary Microbiology and Mycology / N.M. Kolychev, R.G. Gosmanov. — St. Petersburg: Lan, 2024 (replacement for R. Steinier).
9. Maltsev, V.N. Fundamentals of Microbiology and Immunology / V.N. Maltsev. — Moscow: Medicine, 2025.
10. Smirnova, L.I. Sanitary-Microbiological Control of Environmental Objects / L.I. Smirnova. — St. Petersburg: Giord, 2025.