Microbes

and your body

Science group presentation for Halesworth and District u3a

June 2026

Connie Topping

What is a microbe?

A microbe (short for *microorganism*) is a microscopic living organism that is too small to be seen with the naked eye. Microbes include bacteria, viruses, fungi, protozoa, and some algae.

They can live in almost every environment on Earth—soil, water, air, extreme environments, and inside other living things. Some microbes are beneficial (such as those that help digest food or produce oxygen), while others can cause disease.

Our makeup

Key Estimates and Variables

- **Total Human Cell Count:** Most leading research identifies a range between **30 and 40 trillion** cells.
- **Gender Differences:** Estimates vary by body size and sex. On average, adult males have about **36 trillion** human cells, while adult females have about **28 trillion**.
- **Dominant Cell Types:** Approximately **84–90%** of all human cells are red blood cells. Despite their vast numbers, they make up only a small fraction of the body's total mass because they are extremely small.

Most Common Cell Types

While there are over **200 different cell types** in the body, the distribution is highly uneven:

- **Red Blood Cells:** These are the most numerous, making up about **84%** of the total count (roughly 25–30 trillion).
- **Platelets:** The second most abundant, accounting for nearly **5 trillion**.
- **Other Significant Cells:** These include white blood cells, skin cells, and neurons (~86 billion in the brain).

All human body cells are eukaryotic at least when they are generated.

Mature red blood cells

Human cells are eukaryotic, that is they have a nucleus. The only exception are mature red blood cells

How the process works

1. **Hematopoietic stem cells** in the bone marrow can become all blood cell types.
2. Some commit to the red blood cell line and develop into immature precursors.
3. These precursors make large amounts of **hemoglobin**, the oxygen-carrying protein. As they mature, they **shrink, condense, and eject their nucleus**.
4. They become **reticulocytes** (young RBCs), enter the bloodstream, and finish maturing into **erythrocytes** within about 1–2 days.

What controls production

The kidneys monitor oxygen levels. If oxygen is low (for example at high altitude, blood loss, or anemia), they release **erythropoietin (EPO)**, a hormone that tells the bone marrow to make more red blood cells. Erythropoietin

How long they last

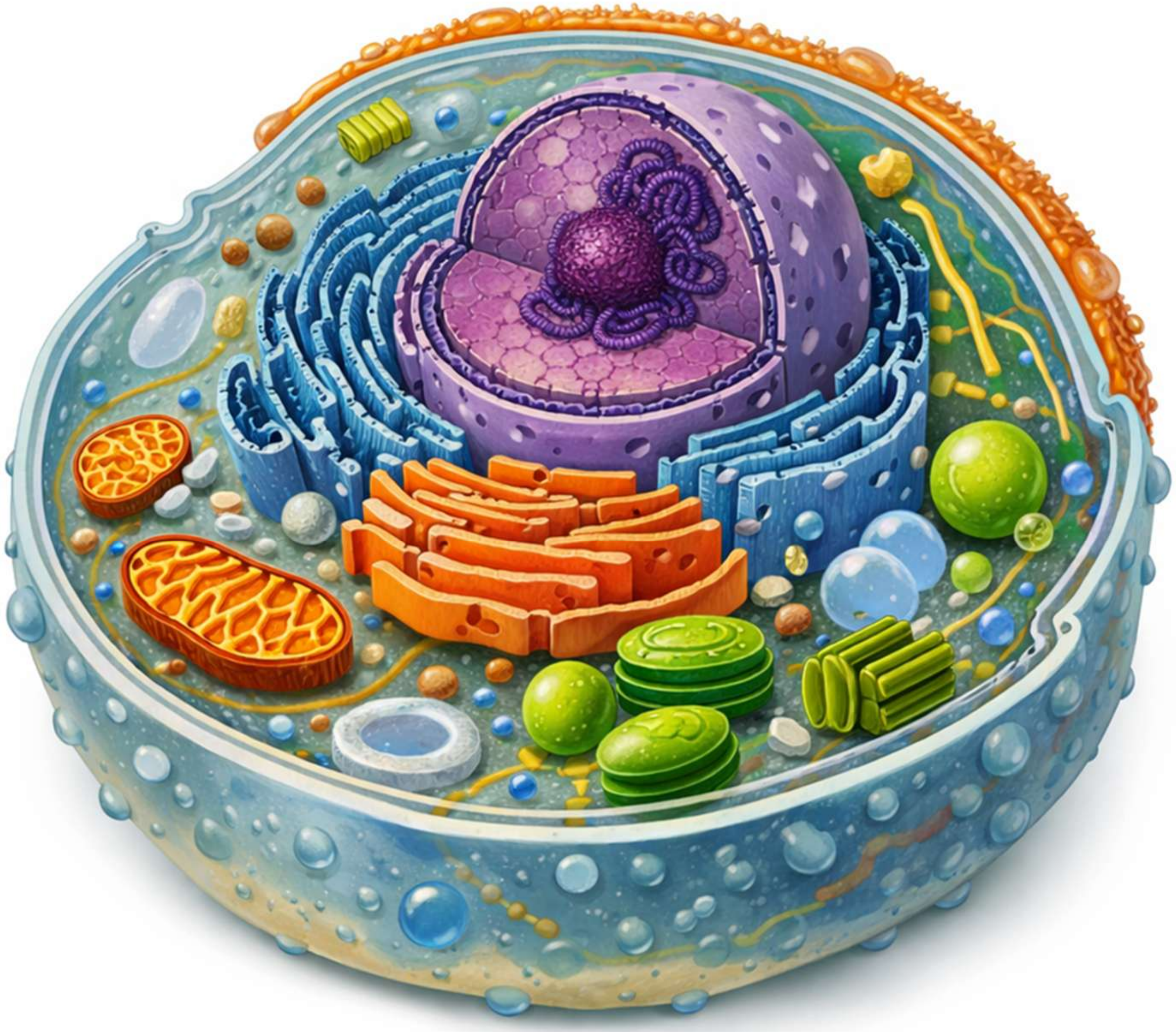
Mature red blood cells circulate for about **120 days**, then are removed mainly by the spleen and replaced continuously.

Simple summary

Stem cell → precursor cells → nucleus expelled → young RBC → mature red blood cell.

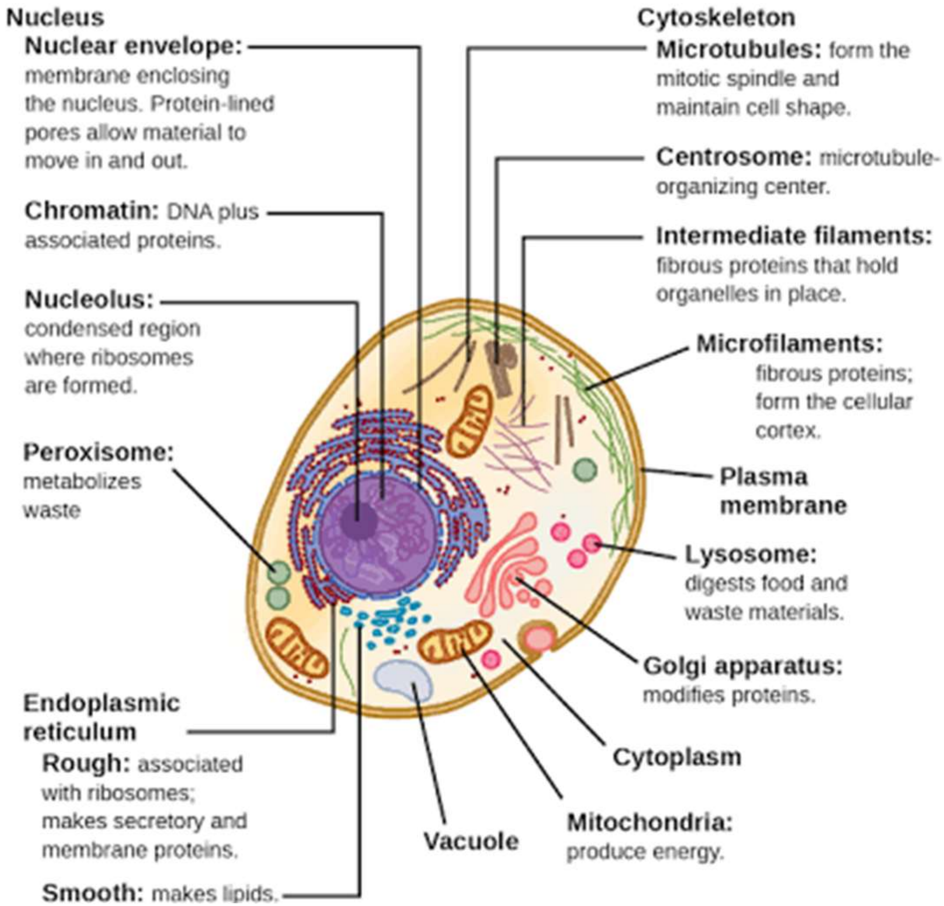
Eucariotic cell

chatgpt



Eukariotic cell

diagram



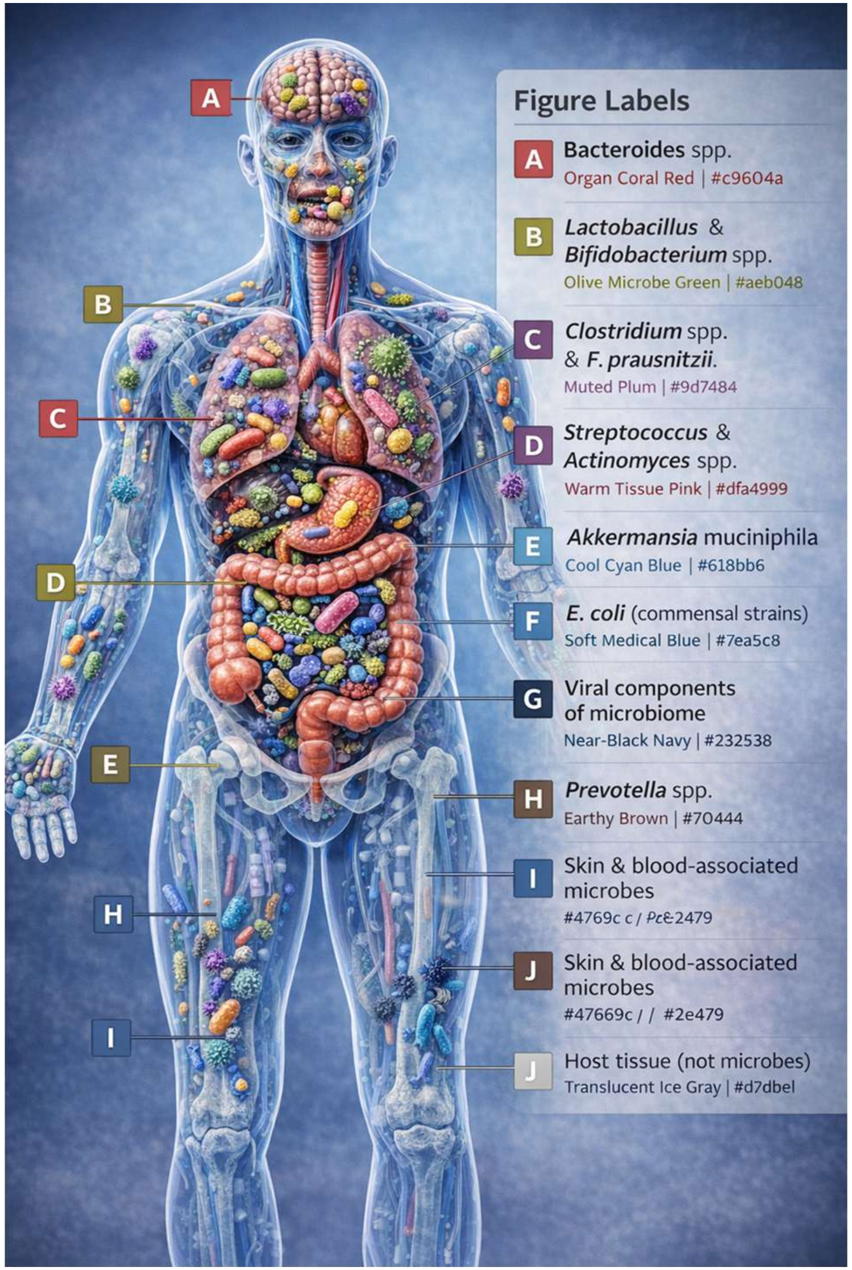
Microbiome: The Non-Human Count

In addition to human cells, your body hosts a vast population of **microbes**. Modern estimates suggest there are roughly **38 trillion bacterial cells** living **in** or **on** a typical human. This creates a nearly 1:1 ratio between human and bacterial cells, debunking older theories that bacteria outnumber human cells 10:1.

The body is dynamic; it is estimated that about **330 billion cells die and are replaced every day**. Most of these are blood cells and cells lining the intestines. They are disposed off in faeces and shed from the skin. **50 % of faeces is dead cell material.**

Microbes in the human body

Types of microbes



1. **Bacteria (The Dominant Group) in the body biome**.

Bacteria are the most abundant and well-studied members of the gut biome, representing approximately **99%** of the total microbial population.

- **Major Phyla:** Over 90% of gut bacteria belong to two main groups: **Bacteroidota** (formerly Bacteroidetes) and **Bacillota** (formerly Firmicutes).
- **Key Genera:** Common beneficial genera include *Bifidobacterium*, *Lactobacillus*, and *Faecalibacterium*.
- **Pathogenic Potential:** In small numbers, potentially harmful bacteria like *Escherichia coli* and *Clostridium* species coexist within a healthy biome.

🦠 1. Gut Microbiome (Intestines)

- Most abundant and diverse microbial community in the body
- Major bacterial groups:
  - Firmicutes (e.g., *Lactobacillus*, *Clostridium*)
  - Bacteroidetes (e.g., *Bacteroides*, *Prevotella*)
  - Actinobacteria (e.g., *Bifidobacterium*)
  - Proteobacteria (e.g., *Escherichia coli*)
  - Verrucomicrobia (e.g., *Akkermansia muciniphila*)
- Functions: digestion, vitamin production (e.g., K, B12), immune development, metabolism regulation

Lactobacilli

Lactobacilli serve as critical guardians of the gastrointestinal tract by maintaining microbial balance, strengthening the gut barrier, aiding digestion, and regulating the immune system. Though they make up a relatively small percentage of the total native gut microbiota, these lactic acid-producing bacteria exert a **disproportionately powerful impact** on overall human health.

Niche Occupation: **They physically bind to the gut's mucosal lining**, leaving no room or nutrients for harmful pathogens like *E. coli* or *Clostridioides difficile* to take hold.

Acid Production: **They ferment carbohydrates into lactic acid, lowering the local pH level**. This acidic environment is highly toxic to dangerous microbes but completely safe for beneficial flora.

Antimicrobial Secretion: **They produce specialized natural defense weapons**, such as **bacteriocins** and **hydrogen peroxide**, which directly kill or inhibit competing pathogens.

Lactobacillus

Strengthening the Intestinal Barrier

The gut lining must remain selectively permeable—letting nutrients pass through while blocking toxins.

Lactobacilli protect this barrier:

- Tight Junction Repair: They stimulate the production of transmembrane and cytoplasmic proteins that tightly lock intestinal epithelial cells together, preventing "leaky gut" syndrome.

- Mucus Shield Enhancement: They trigger goblet cells to secrete a thicker layer of protective mucin (mucus) across the intestinal tract, which keeps pathogens from physically touching and invading the cell wall.

Digesting Food and Creating Nutrients

Lactobacilli are highly active metabolic engines that extract energy from the things humans cannot digest.

- SCFA Production: They break down dietary fibers to yield short-chain fatty acids (SCFAs), such as acetate and butyrate, which fuel and repair the cells lining the colon.
- Lactose Breakdown: They produce the enzyme lactase, which breaks down milk sugar (lactose) into simpler sugars, directly helping to alleviate symptoms of lactose intolerance.
- Toxin Degradation: Certain strains breakdown specific harmful compounds from our food, such as dietary oxalates, which can otherwise build up and cause painful kidney stones.

4. **Training and Regulating the Immune System**

Lactobacilli engage in "bidirectional crosstalk" with the immune cells located right behind the intestinal wall.

- **Immune Response Tuning**: They trigger the release of anti-inflammatory cytokines while safely modulating localized inflammation, helping to calm hyper-reactive states like those found in Irritable Bowel Syndrome (IBS) or Inflammatory Bowel Disease (IBD).
- **Antibody Boosting:** They stimulate the gut's production of Immunoglobulin A (IgA), an antibody essential for neutralizing viral and bacterial threats locally before they can breach into the wider bloodstream

Bacteroidetes

The genus **Bacteroides** function as the **primary heavy machinery for carbohydrate digestion** and metabolic regulation in the human gut. While *Lactobacilli* act like protective border guards, *Bacteroidetes* make up a massive portion of your native microbiome (often up to 30% to 50%) and act as the core workforce driving your daily metabolism.

1. **Breaking Down Complex Carbohydrates**

Humans lack the cellular machinery to digest complex plant fibers, but *Bacteroidetes* specialize in this exact task.

- Polysaccharide Harvesting: They possess extensive clusters of genes called Polysaccharide Utilization Loci (PUL). This genetic toolkit allows them to shred complex starches, xylans, and cellulose from foods like oats, beans, and vegetables.
- The "Backup" Mucus Diet: If you do not eat enough dietary fiber, certain species like *Bacteroides thetaiotaomicron* can shift their diet to forage on the sugars found in your body's natural gut mucus layer. This keeps them alive during periods of fasting or low-carb dieting

2. **Teamwork with Archaea**

***Bacteroidetes* are the primary drivers of the gut's "exhaust system" loop that we just covered.**

- The Hand-off: As *Bacteroidetes* rapidly shred plant fibers, they generate large amounts of hydrogen gas [1].
- The Disposal: The *Archaea* (methanogens) immediately absorb this gas to keep the environment stable. If you lack *Bacteroidetes*, the *Archaea* lose their primary food source.

3. Managing Your Weight and Metabolism

The balance of *Bacteroidetes* relative to other bacterial groups is heavily intertwined with how your body stores fat.

- The "Lean" Bacteria Phenotype: Scientific studies consistently show that individuals with higher ratios of ***Bacteroidetes* to *Firmicutes*** (the other dominant gut phylum) tend to be leaner. Caloric Control: A higher abundance of *Bacteroidetes* is associated with more efficient metabolic function. Recent neuroscience and microbiome research highlights their direct communication lines to the central nervous system.

4. Supporting the Gut-Brain Axis and Hormones

- Hormone Signaling: They stimulate specialized endocrine cells in your intestinal lining to secrete GLP-1 (which regulates insulin and signals fullness to the brain) and serotonin (which controls gut motility and mood).
- Lower tendency to harvest and store excess calories from food.

5. Keeping the Gut Environment Safe (Oxygen Scavenging)

The deepest parts of your colon must remain completely free of oxygen for beneficial, strict anaerobes to survive.

- *Bacteroidetes* consume and clear out trace amounts of leaking oxygen, creating a safely sealed, oxygen-free habitat where your entire microbial ecosystem can thrive.

The "Jekyll and Hyde" Caveat

Unlike *Lactobacilli*, which are almost always docile, *Bacteroidetes* have a dual nature. They are incredibly safe and beneficial inside the sealed tube of your digestive tract. However, if the gut barrier breaches (due to surgery, severe injury, or disease), species like ***Bacteroides fragilis*** can escape into the sterile bloodstream or abdomen, where they can cause serious infections or abscesses.

Actinobacteria (specifically the Bifidobacteria genus)

function as a pivotal minority that anchors early-life gut development, breaks down complex plant and milk sugars, protects the gut lining, and directly trains the immune system.

While they generally make up only 1% to 5% of a healthy adult's native gut microbiome, they are considered a cornerstone "keystone phylum." **Without them, the gut environment degrades into a state of systemic inflammation and dysbiosis.**

1. Driving Early-Life Gut Development

Actinobacteria are the absolute pioneers of the human digestive system.

- Infant Dominance: In breastfed infants, the Actinobacteria genus *Bifidobacterium* makes up up to 90% of the entire gut microbiome.
- HMO Digestion: They possess highly unique enzymes specialized to break down Human Milk Oligosaccharides (HMOs)—complex sugars in breast milk that infants cannot digest on their own. This process safely colonizes and seals the infant's pristine gut.
- Adult Transition: As humans transition to solid foods, adult-centric bacteria multiply, causing Actinobacteria levels to naturally drop to their stable adult baseline of under 5%.

2. Fermenting Prebiotics and Dietary Fibers

In adults, Actinobacteria continue to act as premium carbohydrate fermenters.

- Specialized Diet: They specifically thrive on prebiotics like Inulin, Fructooligosaccharides (FOS), and Galactooligosaccharides (GOS) found in foods like garlic, onions, asparagus, and bananas.
- Cross-Feeding Ecosystem: When Actinobacteria ferment these fibers, they produce acetate and lactate. Other native gut microbes (like *Firmicutes*) catch these waste products and convert them into butyrate, the critical short-chain fatty acid that fuels, repairs, and protects the cells lining your colon.

- ## 3. Fortifying the Intestinal Barrier

Actinobacteria work continuously to prevent toxins from breaching into your bloodstream.

- Tight Junction Regulation: They stimulate the expression of claudin and occludin proteins, which physically glue your gut cells tightly together to prevent "leaky gut" syndrome.
- Pathogen Shielding: By maintaining a slightly acidic environment through organic acid production, they inhibit dangerous pathogens like *Salmonella* and *E. coli* from multiplying. [1]

4. Direct Immune System Modulation

Actinobacteria engage in a continuous, active dialogue with your body's immune cells.

- Anti-Inflammatory Response: They actively trigger the production of regulatory T-cells (Tregs) and anti-inflammatory cytokines (such as IL-10). This process continuously desensitises your immune system so it does not overreact to harmless food proteins, helping to protect against autoimmune diseases and allergies.

5. Managing the Gut-Brain Axis

Members of this phylum are considered "psychobiotics" because of their profound downstream impact on mental health and stress.

- Neurotransmitter Support: They are actively involved in pathways that synthesize precursors for GABA (the brain's primary calming neurotransmitter) and serotonin. Low baseline levels of adult Actinobacteria are frequently observed in clinical studies tracking individuals with depression, anxiety, and chronic fatigue.

Proteobacteria

function as a dynamic warning system, environmental balancer, and inflammatory trigger in the human gut. Unlike *Lactobacilli*, *Bacteroidetes*, and *Actinobacteria*—which are primarily beneficial—*Proteobacteria* are a high-stakes, erratic phylum. [1, 2, 3, 4]

In a healthy adult, they should remain a strict minority, **making up under 2% to 5%** of the total microbiome. When kept at low levels, they serve vital physiological tasks, but if they "bloom" or overgrow, they become a primary driver of gut disease and systemic inflammation.

1. Oxygen Scavenging (The Clean-up Crew)

The deep parts of the large intestine must be an absolute anaerobic (zero-oxygen) environment for your beneficial fiber-digesting bacteria to survive.

- Consuming Residual Oxygen: *Proteobacteria* are "facultative anaerobes," meaning they can live with or without oxygen. They consume any trace oxygen that leaks out of the gut tissue into the intestinal space.
- Creating a Safe Haven: By eating up this oxygen, they create a perfectly sealed, oxygen-free habitat that allows essential, strict anaerobes (like *Bacteroidetes* and *Firmicutes*) to live and digest your food.

2. Vitamin Synthesis

Like other native bacteria, commensal (friendly) strains of *Proteobacteria* actively help meet your daily nutritional needs.

- Nutrient Generation: They contain genetic pathways that synthesize essential micronutrients, particularly Vitamin K (crucial for blood clotting and bone health) and various B-vitamins, which support cellular energy metabolism.

3. The "Microbial Signature" of Gut Instability

The most critical feature of *Proteobacteria* is their tendency to rapidly overgrow when the gut becomes compromised. In medicine, an expansion of this phylum is widely recognized as the classic biomarker for dysbiosis (microbiome imbalance).

- **Thriving on Inflammation**: When the gut lining is stressed, inflamed, or damaged by a poor diet, your intestinal cells release oxygen and nitrates. While beneficial bacteria are killed by this change, *Proteobacteria* feast on these compounds, causing their population to explode.
- The **Antibiotic Wipeou**t: Because they are highly resilient, *Proteobacteria* are often the first to rapidly rebound after a heavy round of broad-spectrum antibiotics, taking over the empty space before healthy bacteria can recover.

4. **Feeding Chronic Inflammation**

The cell walls of *Proteobacteria* contain a highly reactive molecule called Lipopolysaccharide (LPS), also known as an endotoxin.

- Immune Alarm: When *Proteobacteria* multiply excessively, massive amounts of LPS pour into the gut. Your immune system recognizes LPS as an immediate threat, triggering a powerful, destructive inflammatory response.
- Systemic Disease Link: This chronic LPS-driven inflammation is heavily linked to the progression of Inflammatory Bowel Disease (IBD), Irritable Bowel Syndrome (IBS), Type 2 Diabetes, and Metabolic Syndrome.

Notable Members of this Phylum

This group contains standard, benign gut residents, but it also houses notorious human pathogens. An unbalance can cause an overgrowth of:

- *Escherichia coli (E. coli)* (both harmless commensal strains and pathogenic strains)
- *Salmonella*
- *Helicobacter pylori* (the main driver of stomach ulcers)

Verrucomicrobia

Verrumicrobia function as the premier mucus-managers and gut-barrier guardians of the human digestive tract. Like *Actinobacteria*, they are a crucial keystone phylum that typically makes up only 1% to 5% of a healthy adult's total microbiome.

Almost all human gut research on this phylum focuses on its standout species: *Akkermansia muciniphila*. This single bacterium exerts a massive influence over your metabolic health, insulin sensitivity, and gut lining integrity.

Verrucomicrobia

1. Pruning and Refreshing the Gut Shield

Unlike most gut bacteria that feed on the fiber from your diet, *Akkermansia* is a "mucus specialist."

- The Mucus Diet: It specifically eats mucin, the complex sugar-protein matrix that makes up the thick, protective mucus layer lining your intestines.
- The Continuous Loop: By grazing on this mucus, it tricks your intestinal goblet cells into producing fresh, clean mucin. This constant pruning cycle prevents the gut shield from becoming stagnant, thin, or easily breached by pathogens.

2. Preventing "Leaky Gut" and Toxemia

By constantly stimulating fresh mucus production, Verrucomicrobia act as a physical wall against systemic illness.

- Sealing Tight Junctions: They release signal molecules that instruct your gut cells to manufacture more tight junction proteins (like claudin and occludin).
- Stopping Endotoxins: This tight seal prevents dangerous toxins—like the inflammatory LPS produced by *Proteobacteria*—from escaping the gut and leaking into your bloodstream.

3. Tuning Your Insulin Sensitivity and Weight

Verrucomicrobia are heavily intertwined with your baseline metabolic rate and how your body processes sugar.

- The Metformin Connection: Clinical studies show that individuals with obesity or Type 2 diabetes consistently have very low or undetectable levels of *Akkermansia*. Notably, the first-line diabetes drug Metformin naturally boosts *Akkermansia* levels.
- Burning Fat: They produce the short-chain fatty acids acetate and propionate. These specific acids travel to adipose (fat) tissue, where they stimulate fat-burning pathways and lower system-wide insulin resistance.

4. Calming Chronic Inflammation

Verrucomicrobia play a peacekeeper role within your immune system.

- Taming Cytokines: Their presence suppresses pro-inflammatory signaling chemicals in the gut.
- Protecting the Brain: By dampening systemic inflammation, higher levels of Verrucomicrobia are strongly correlated with a reduced risk of neurodegenerative issues, making them an important piece of the gut-brain axis

How to Feed Them (Since You Cannot Eat Them)

You cannot easily take *Akkermansia* as a standard, live probiotic because it dies instantly when exposed to the slightest bit of oxygen during manufacturing. Instead, you must feed your native population:

- Polyphenols: They absolutely thrive on polyphenol-rich foods like pomegranates, cranberries, dark grapes, green tea, and cocoa.
- Fasting: Because they eat your body’s natural mucus rather than food fiber, short periods of intermittent fasting allow them to out-compete other bacteria and safely multiply.

Summary

Together, these microbial communities:

- Aid digestion & nutrient absorption. 90% of our food is processed by them for our blood to absorb and carry to where it is needed.
- Modulate immune function
- Protect against pathogenic microbes
- Influence mood and metabolism (gut–brain axis)

Main roles of the appendix (previously thought to be a redundant organ)

1. Immune system support

The appendix contains **lymphoid tissue**, especially in childhood and young adulthood. This tissue helps expose immune cells to microbes from the gut and may contribute to immune training. Lymphoid tissue

2. Reservoir for beneficial gut bacteria

One leading theory is that the appendix can act as a **safe house** for helpful gut microbes. After diarrhea or intestinal infection flushes bacteria out, microbes from the appendix may help recolonize the colon. Gut microbiome

3. Minor role in gut ecology

It may help regulate mucus, biofilms, and interactions between microbes and the intestinal lining.

Is it essential?

No. People can live normal, healthy lives after an **appendectomy** (surgical removal of the appendix), which means it is **helpful but not vital**. Appendectomy

When it causes problems

The appendix is best known because it can become inflamed or blocked, causing **appendicitis**, which may require urgent treatment. Appendicitis

Evolutionary note

In some herbivorous mammals, cecal/appendix-like structures are more involved in fermentation of plant material. In humans, the role appears more immune/microbiome-related than digestive.

Simple summary The appendix is probably a **small immune organ and microbial refuge**, not a useless leftover.

😷 2. Skin Microbiome

- Found on all skin surfaces — varies by moisture, temperature, and exposure
- Main bacterial groups:
  - *Staphylococcus* (e.g., *S. epidermidis*, *S. aureus*)
  - *Corynebacterium*
  - *Propionibacterium* (especially *Cutibacterium acnes*)
- Functions: protects from pathogens, supports skin immunity

👃 3. **Oral Microbiome**

- Includes bacteria, fungi, and viruses in the mouth and throat
- Common microbes:
  - *Streptococcus* (e.g., *S. mutans*)
  - *Actinomyces*
  - *Neisseria*
  - *Veillonella*
- Functions: start of digestion, balance of oral health, protection from infections

Our Aura, that is the area reached by our breath, contains all these.

👃 4. Nasal and Respiratory Microbiome

- Found in nasal passages and upper respiratory tract
- Common microbes:
  - *Staphylococcus aureus*, *Corynebacterium*, *Moraxella*, *Dolosigranulum*
- Functions: interacts with immune defenses to prevent respiratory diseases

🚺 5. Vaginal Microbiome (in females)

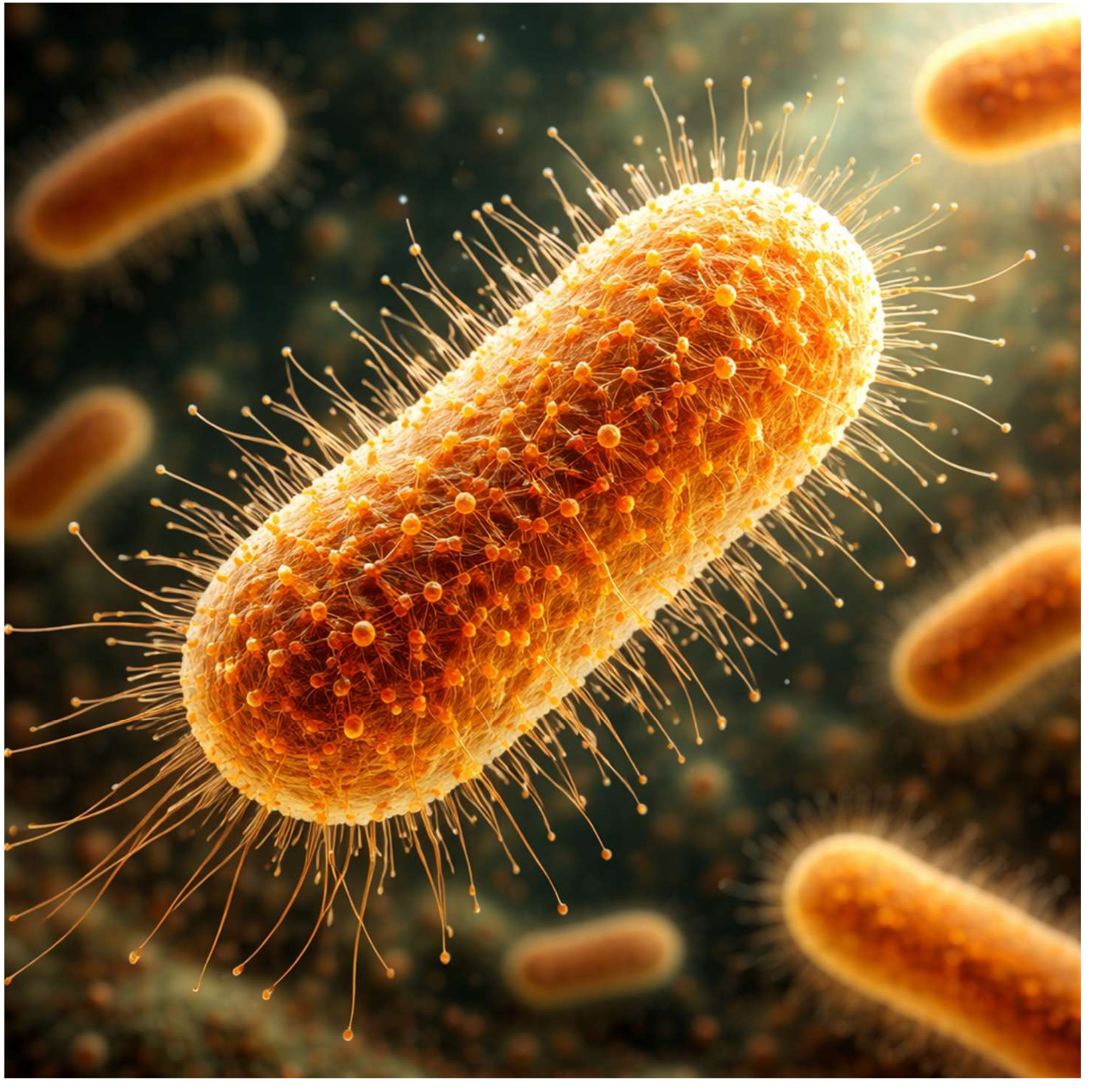
- Dominated by Lactobacillus species (e.g., *L. crispatus*, *L. gasseri*)
- Maintains acidic pH to protect against pathogens

💧 6. Urinary Tract Microbiome

- Once thought to be sterile, now known to contain microbes
- Common microbes: *Lactobacillus*, *Gardnerella*, *Corynebacterium*

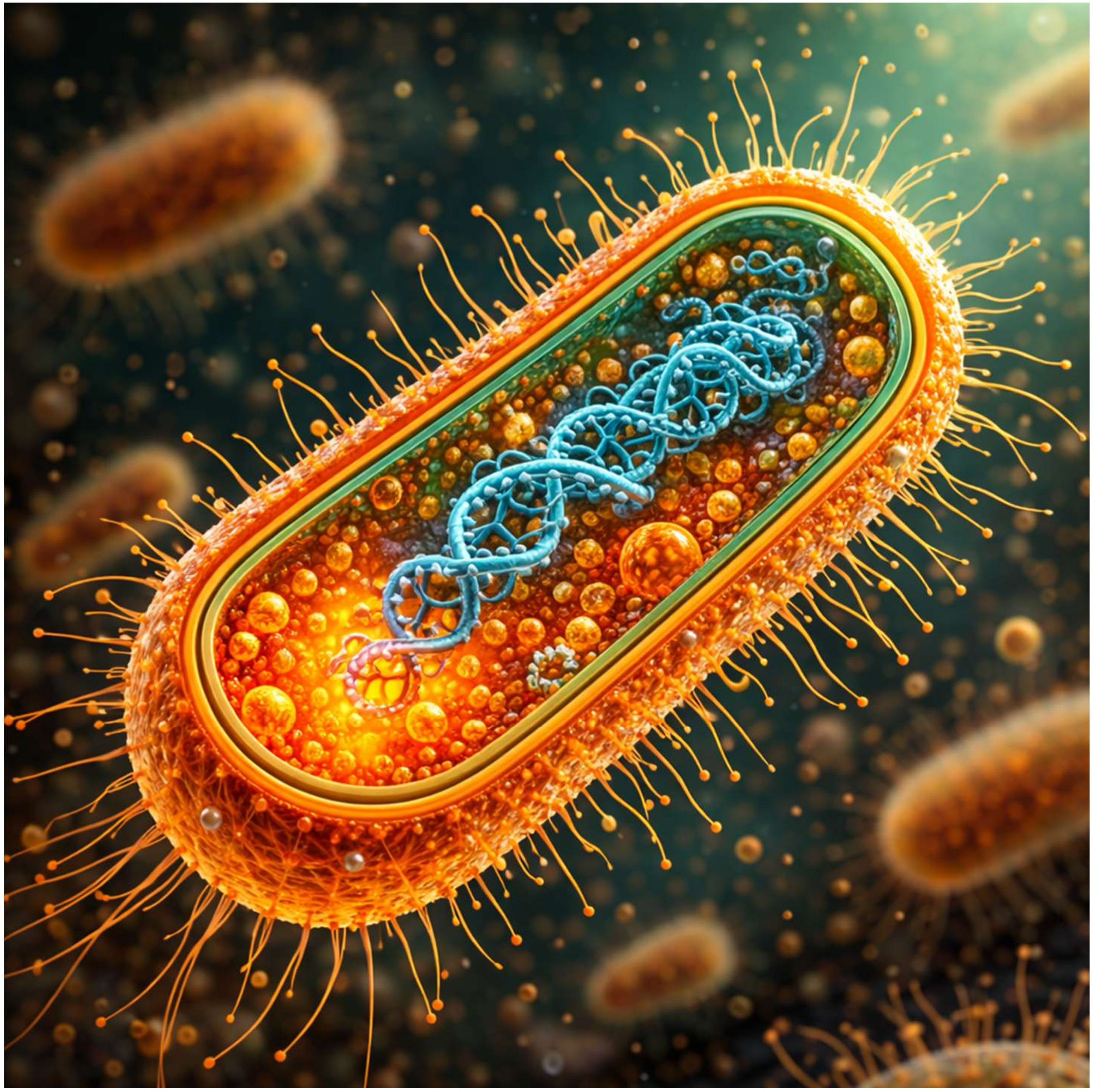
Rod bacterium

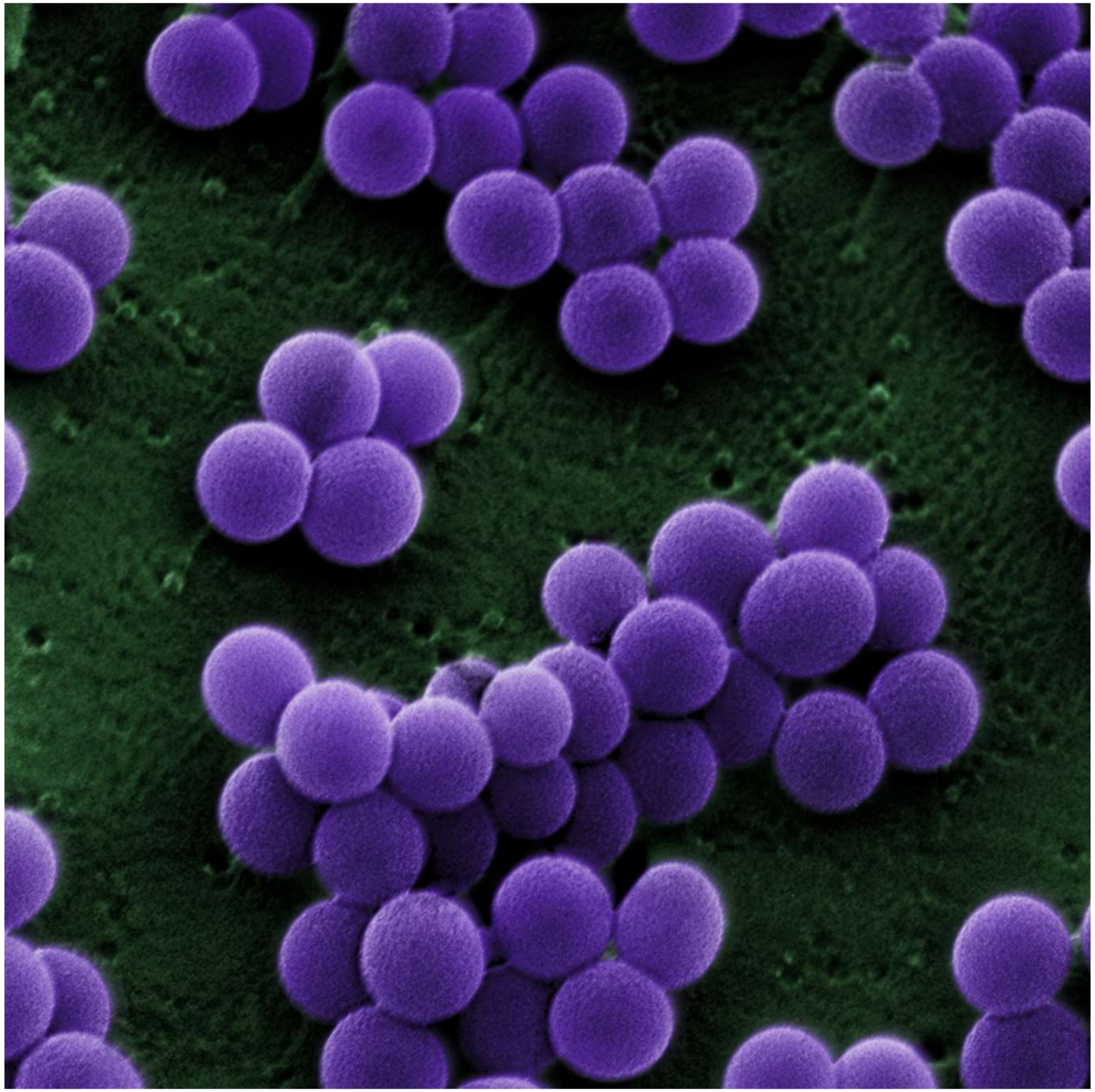
outside



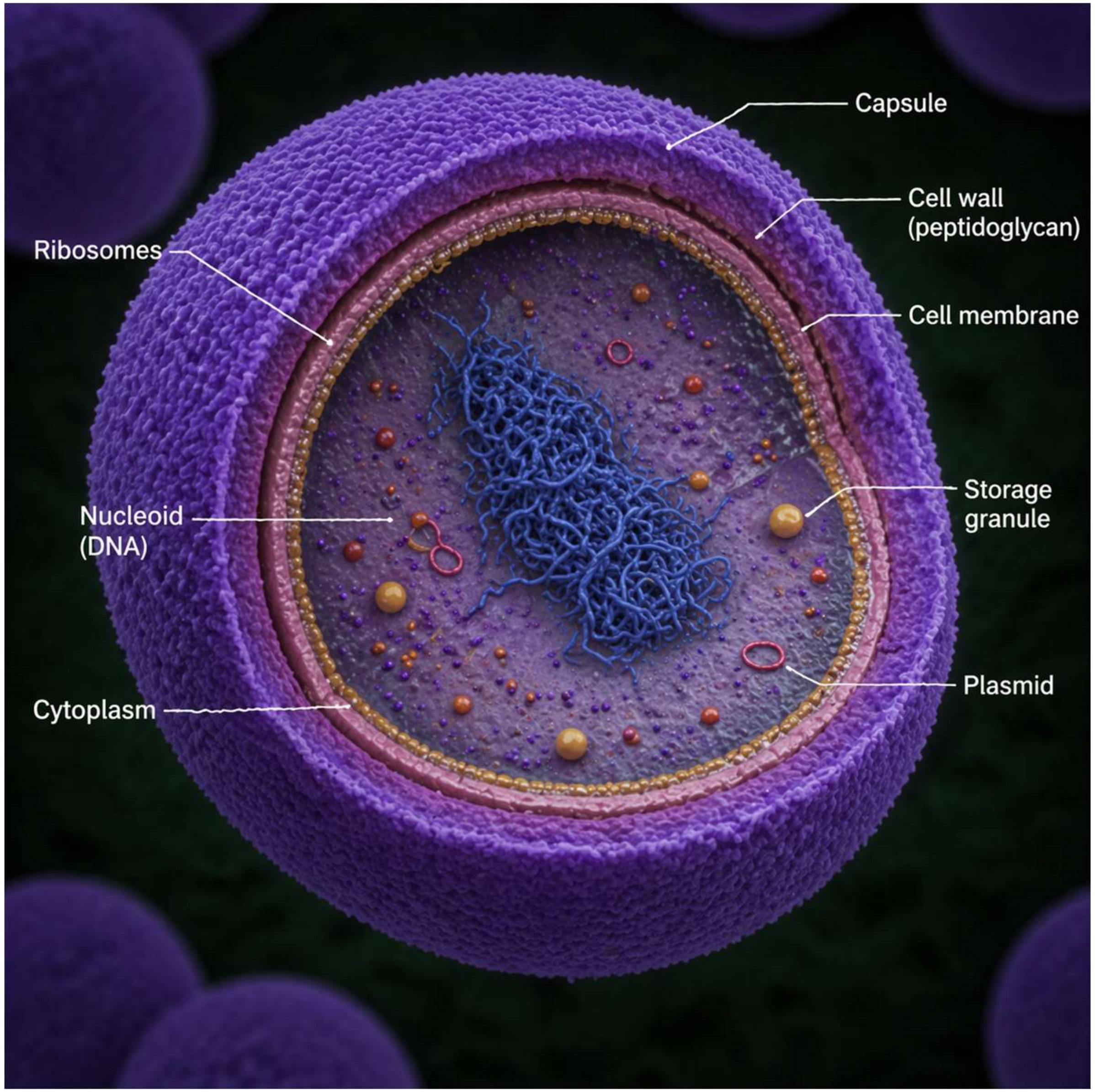
Rod bacterium

inside



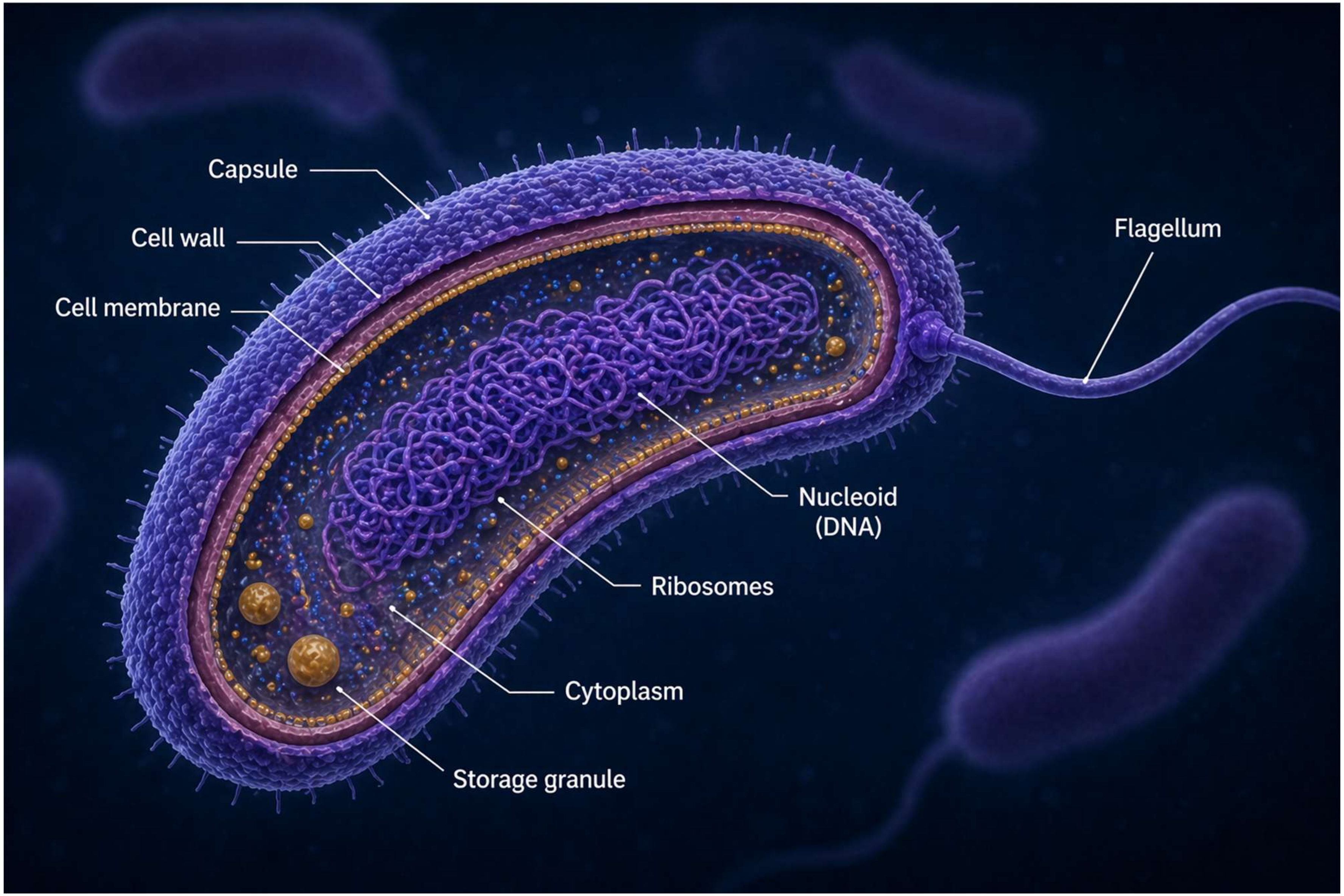


Cocci bacterium

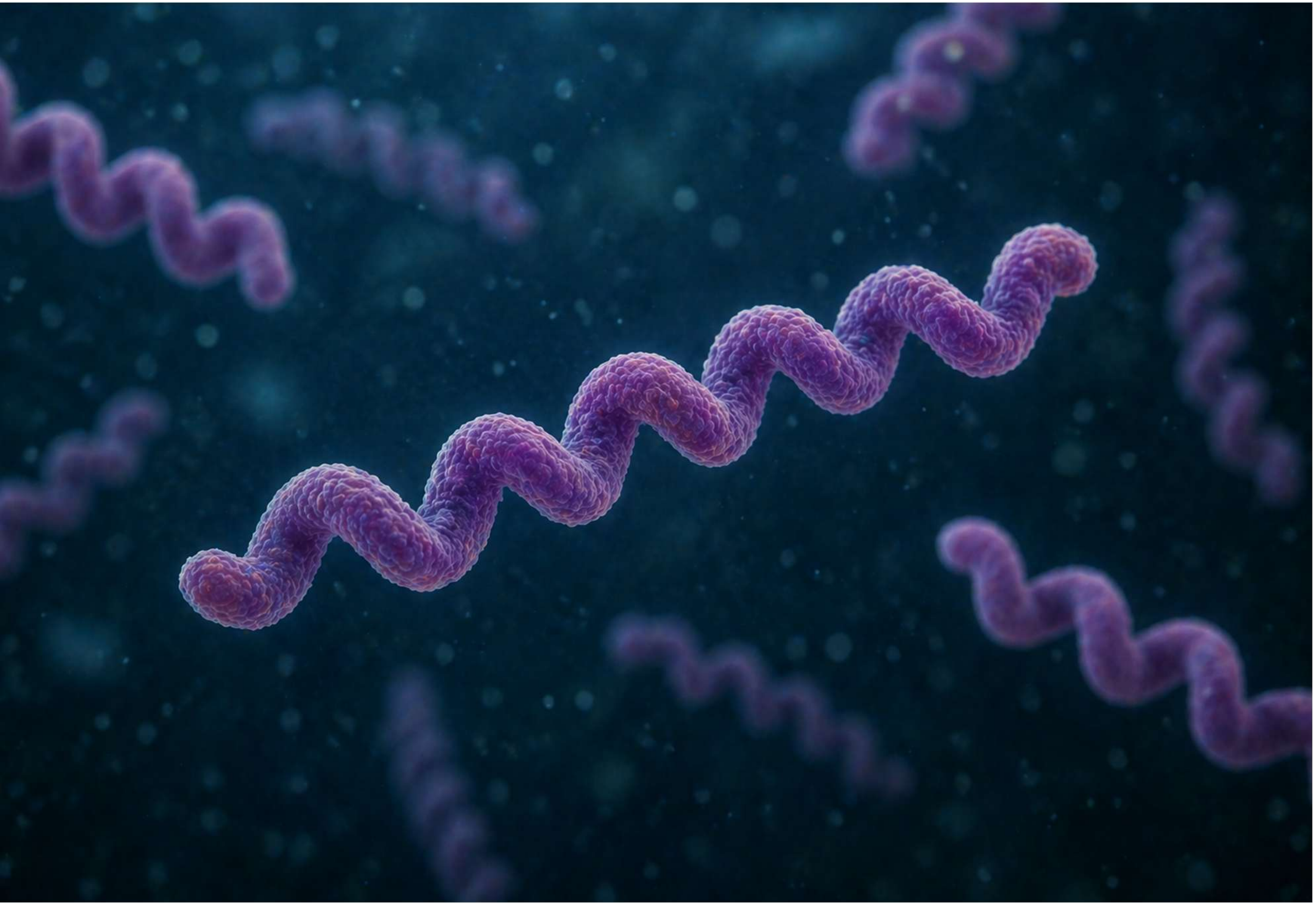

Capsule
Cell wall
(peptidoglycan)
Ribosomes
Cell membrane
Storage
granule
Nucleoid
(DNA)
Plasmid
Cytoplasm

inside

Vibrios
bacterium

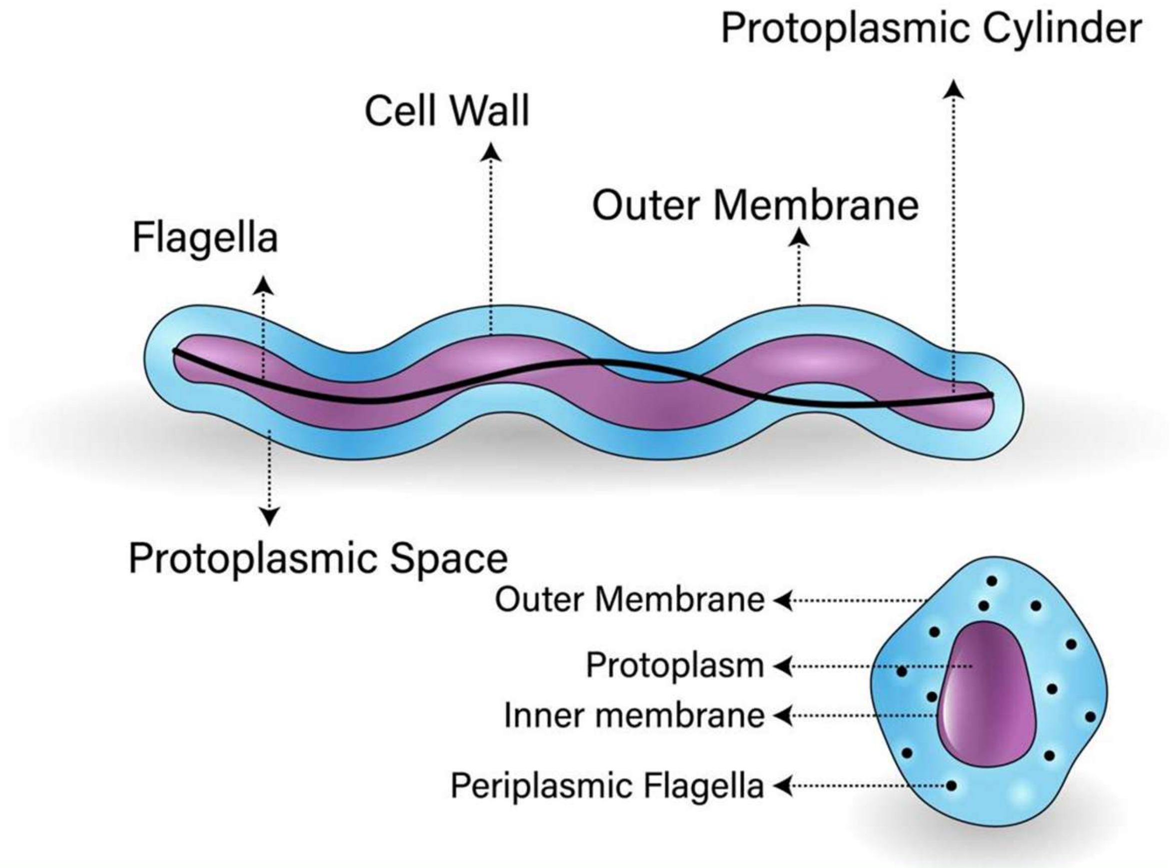

Capsule
Cell wall
Cell membrane
Flagellum
Nucleoid
(DNA)
Ribosomes
Cytoplasm
Storage granule

inside



Spirilla

Spirochete



Spirochete

2. **Other Microorganisms**

While bacteria are the most numerous, the gut biome also includes significant non-bacterial residents:

- **Viruses (The Virome):** Primarily made up of **bacteriophages**, which are viruses that infect and **regulate** bacterial populations.
- **Fungi (The Mycobiome):** Includes genera such as *Candida*, *Saccharomyces*, and *Aspergillus*.
- **Archaea:** Single-celled organisms distinct from bacteria; the most common is *Methanobrevibacter smithii*, which produces methane gas during digestion.
- **Protozoa and Parasites:** Small numbers of single-celled eukaryotes and parasites are often present as part of a normal, diverse ecosystem

Viruses

Viruses are one of the **main pathogenic agents** that have been responsible for an enormous number of different diseases in humans, plants, and animals. These organisms are much simpler in structure as compared to other organisms, as they have no cells or organelles.

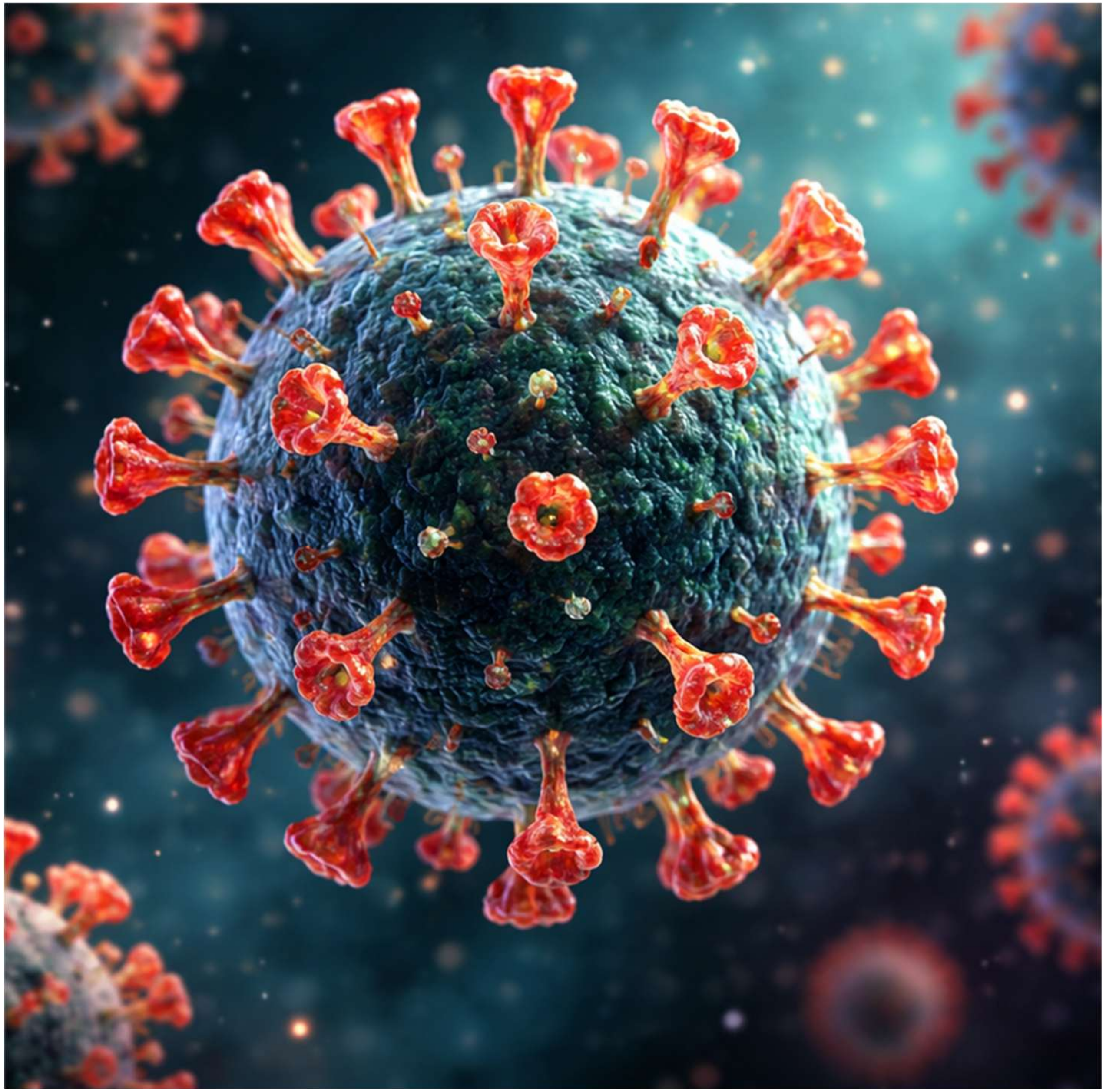
Viruses can only **replicate within a host cell**. When not residing within the host, viruses exist as *virions*. Virions have a simple structure that consists of genetic material, a protein coat (capsid), and, in some cases, a lipid envelope.

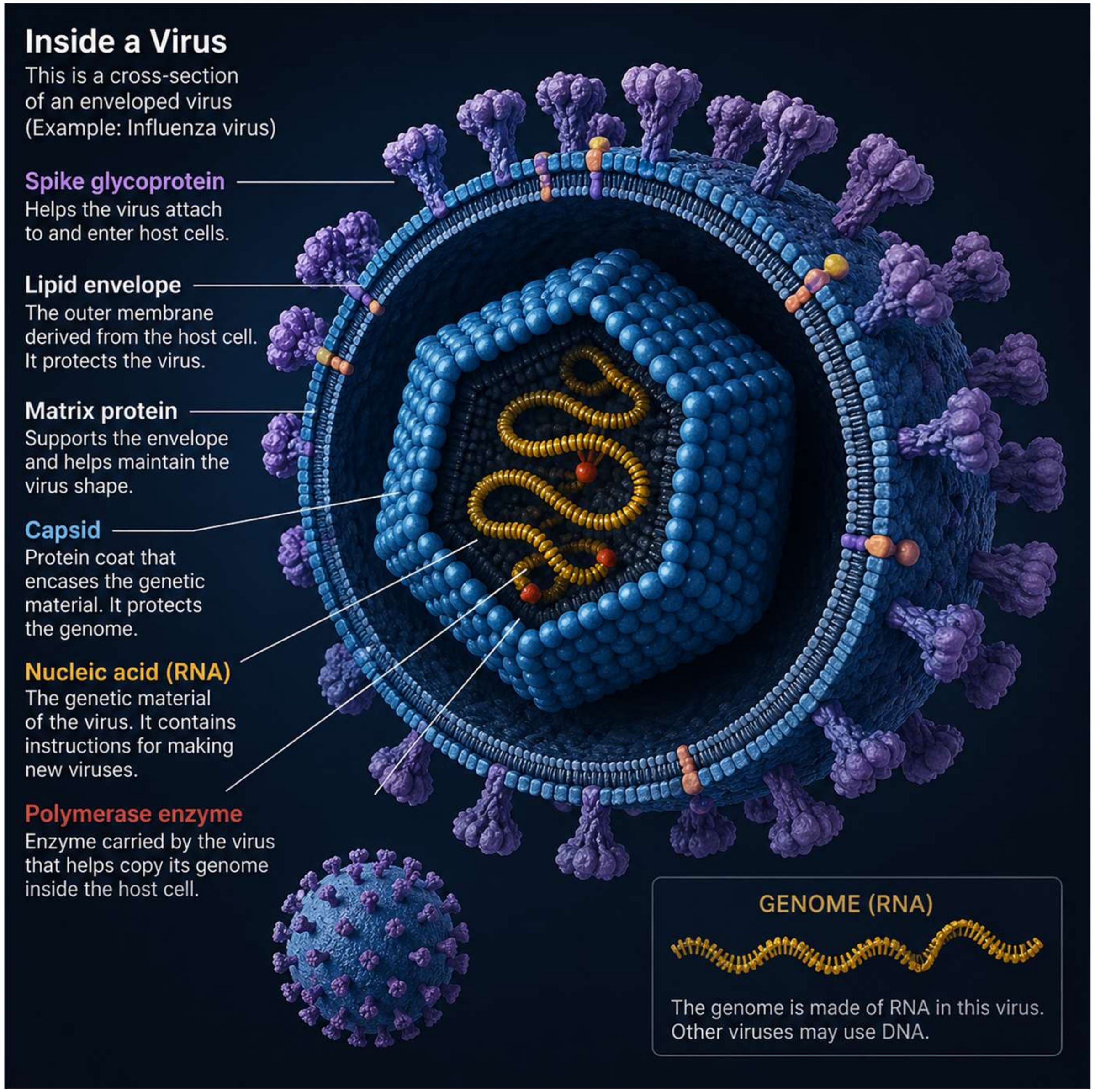
Virions are **the most numerous biological entities on Earth** and mutate much more rapidly than bacteria.

The key **difference between viruses and the other types of microbes** discussed here, aside from prions, is that scientists disagree as to whether viruses are technically **"alive."** This classification depends on one's definition of life.Whilst there is no distinct phylogeny yet identified, viruses exhibit functions that are essential for life. Some can even form protective structures for survival outside the host.

Virus

AI gnerated





Inside a Virus
This is a cross-section of an enveloped virus (Example: Influenza virus)
Spike glycoprotein
Helps the virus attach to and enter host cells.
Lipid envelope
The outer membrane derived from the host cell. It protects the virus.
Matrix protein
Supports the envelope and helps maintain the virus shape.
Capsid
Protein coat that encases the genetic material. It protects the genome.
Nucleic acid (RNA)
The genetic material of the virus. It contains instructions for making new viruses.
Polymerase enzyme
Enzyme carried by the virus that helps copy its genome inside the host cell.
GENOME (RNA)
The genome is made of RNA in this virus. Other viruses may use DNA.

Key Examples of Pathogenic Viruses

- **Respiratory Viruses:** Influenza (Flu), Rhinovirus (Common Cold), SARS-CoV-2 (COVID-19), and RSV.
- **Gastrointestinal Viruses:** Norovirus and Rotavirus, often causing "stomach flu".
- **Hemorrhagic Fever Viruses:** Highly lethal viruses like Ebola, Marburg, and Lassa fever.
- **Chronic and Persistent Viruses:** HIV/AIDS, Hepatitis B and C, and Herpes Simplex.
- **Exanthematous (Rash-causing) Viruses:** Measles, Chickenpox (Varicella-zoster), and Mpox.

Archaea

Archaea are single-celled organisms that form **the third domain of life**. While these organisms are evolutionarily distinct from bacteria, they share several similarities to bacteria.

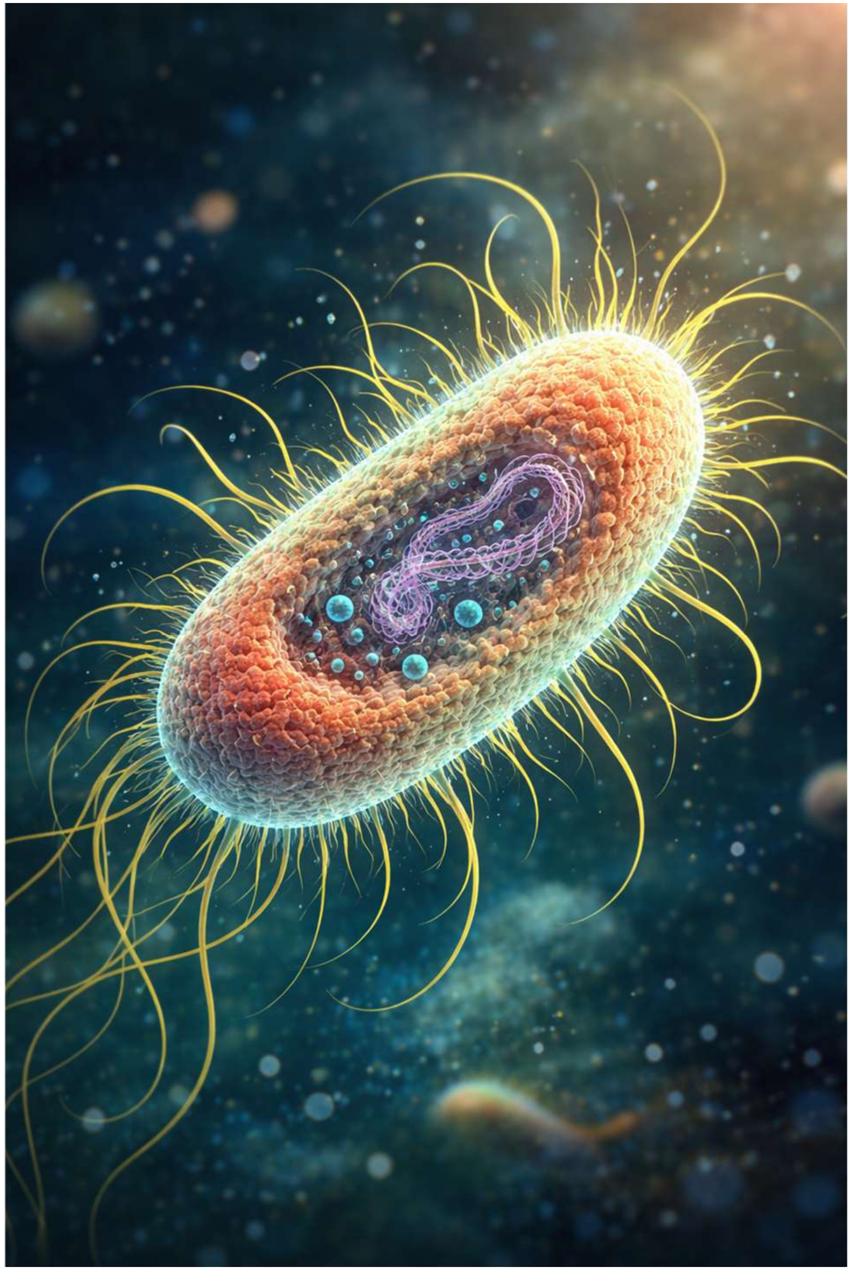
There are some key biological differences between archaea and bacteria. These include a lack of peptidoglycan in the cell wall, as well as the presence of phytanyl instead of fatty acids on the cell membrane.

The cell membrane of bacteria is always a lipid bilayer, whereas in archaea it can sometimes be a monolayer. Archaea also contain distinctive translation ribonucleic acids (tRNAs) and ribosomal RNAs (rRNAs).

Archaea function as the gut's primary chemical optimization system, responsible for disposal of metabolic waste gases and stabilizing the entire digestive process.

Archaea

AI generated



Fungi

The group of eukaryotic organisms known as fungi includes mushrooms, yeast, and molds. These organisms can be either **unicellular** or **multicellular** and can range from micro- to macroscopic in size.

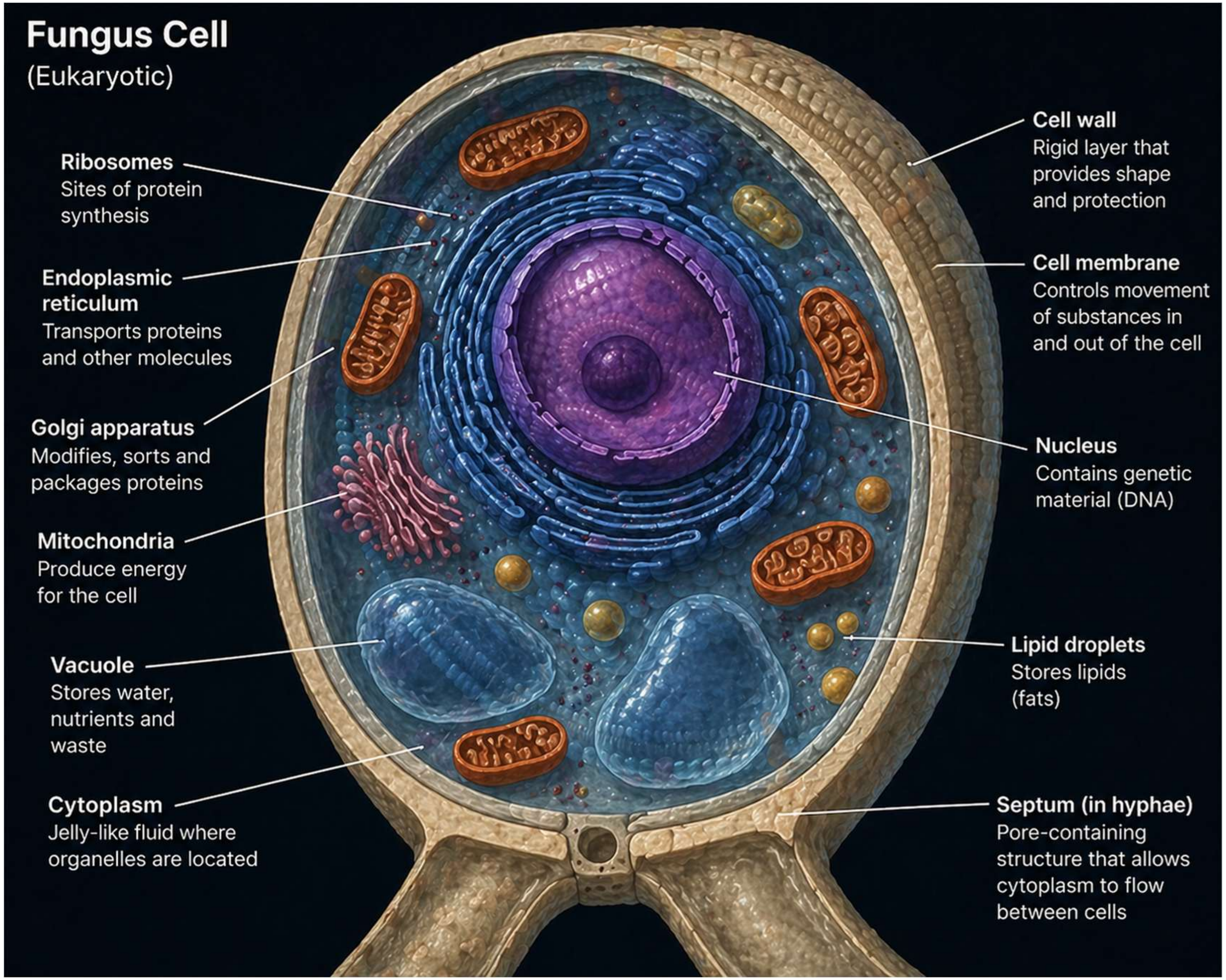
Fungi do not contain chlorophyll and must instead absorb nutrients from their surrounding environment. Of the fungi that are classified as microorganisms, yeasts are unicellular, whereas molds are multicellular and produce microscopic filamentous structures.

They help to break down fibre and sugars in the digestive process….sometimes can produce alcohol!

A condition named **auto brewery syndrome** can occur in people with high sugar diet. It keeps the host **permanently inebriated.**

fungi

AI generated



Fungus Cell
(Eukaryotic)
Ribosomes
Sites of protein synthesis
Endoplasmic reticulum
Transports proteins and other molecules
Golgi apparatus
Modifies, sorts and packages proteins
Mitochondria
Produce energy for the cell
Vacuole
Stores water, nutrients and waste
Cytoplasm
Jelly-like fluid where organelles are located
Cell wall
Rigid layer that provides shape and protection
Cell membrane
Controls movement of substances in and out of the cell
Nucleus
Contains genetic material (DNA)
Lipid droplets
Stores lipids (fats)
Septum (in hyphae)
Pore-containing structure that allows cytoplasm to flow between cells

Main roles of fungi in the gut

1. Help balance the microbial ecosystem

Fungi interact with bacteria—sometimes cooperating, sometimes competing. This can influence which microbes thrive and how stable the gut environment is.

2. Support digestion indirectly

Some fungi can help break down complex carbohydrates and plant materials, contributing to nutrient processing and fermentation.

3. Influence the immune system

The immune system constantly monitors gut fungi. Normal fungal presence can help train immune responses and maintain tolerance.

4. Produce useful metabolites

Fungi may generate compounds that affect inflammation, gut barrier function, and communication with other microbes.

Common gut fungi

One well-known example is Candida albicans, a yeast that often exists harmlessly in small amounts but can overgrow if conditions change (for example after antibiotics or immune disruption).

When balance is disrupted

An unhealthy fungal shift (**dysbiosis**) has been associated with:

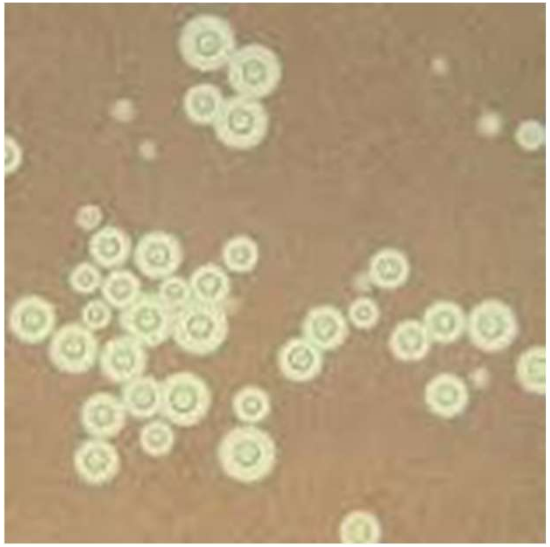
- inflammatory bowel disease
- irritable bowel syndrome
- antibiotic-associated diarrhea
- weakened immunity

Pathogenic Fungi

Not to be confused with Viruses

Candida auris:

A "superbug" yeast often found in hospitals. It is highly resistant to multiple drugs, survives on surfaces for weeks, and can cause fatal bloodstream infections with mortality rates between **30% and 60%**



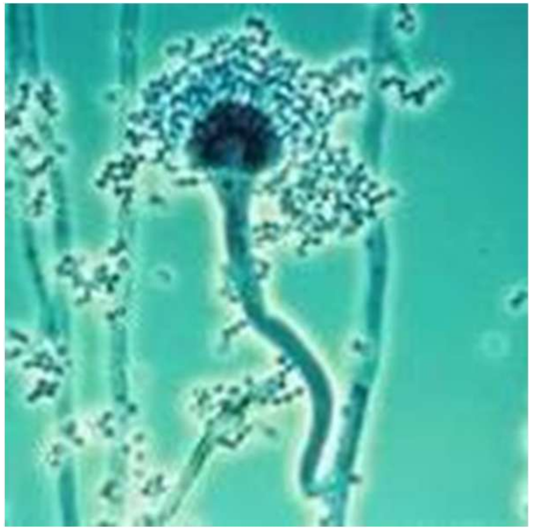
Cryptococcus neoformans:

A yeast often found in soil or bird droppings. It can lead to fungal meningitis, particularly in people living with HIV/AIDS, and has a mortality rate between **41% and 61%**.

Candida albicans

A normal part of human microbiota that can overgrow to cause thrush or life-threatening bloodstream infections (candidemia) with a **20% to 50%** mortality rate.

NPR +4

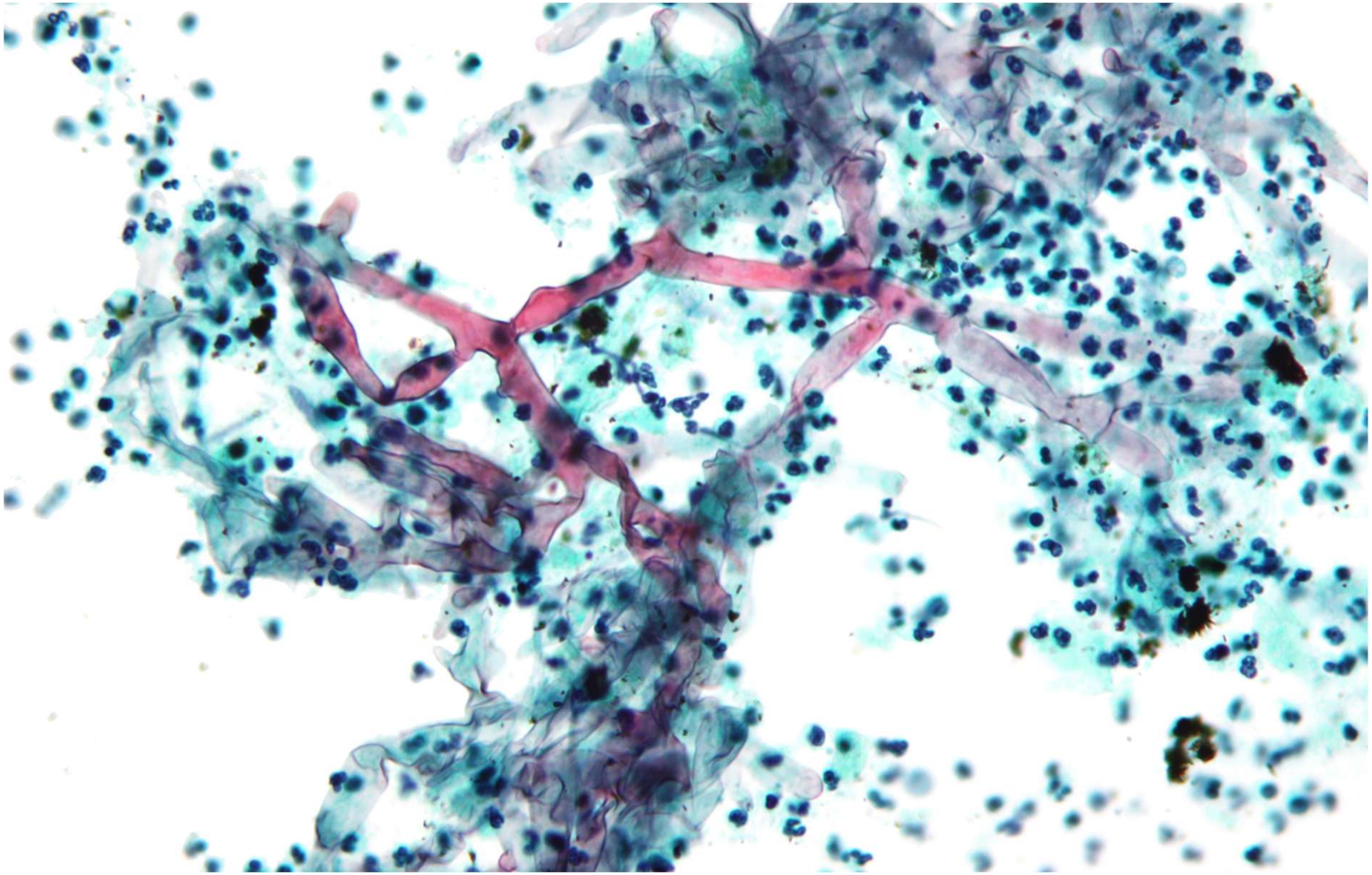


Aspergillus fumigatus:

A common environmental mould found in soil. When inhaled by immunocompromised people, it can "eat" into lung tissue and spread to the brain or heart.40 -80 % mortality rate

- **Mucormycosis ("Black Fungus")**: A rare but aggressive infection caused by environmental moulds. It can lead to rapid tissue death in the sinuses, eyes, and brain, sometimes requiring disfiguring surgery to save the patient's life.

- **Endemic Fungi**: Species like *Histoplasma* (found in bird/bat droppings) and *Coccidioides* (which causes Valley Fever) can cause severe respiratory illness if their spores are inhaled.



Black fungus

Common Visual Presentations of black fungus

- **Cutaneous (Skin) Mucormycosis:** Appears as an area of skin that may be warm, red, and swollen. As it progresses, the tissue often turns black, and blisters or ulcers may form.
- **Rhino-orbital-cerebral Mucormycosis:** This is the most common form, infecting the sinuses and potentially spreading to the eyes and brain. Symptoms include significant facial swelling, periorbital (around the eye) edema, and dark, necrotic-appearing scabs (black eschars) within the nasal cavity or on the roof of the mouth.
- **Microscopic Appearance:** Under a microscope, the fungi appear as broad, ribbon-like, non-septate hyphae (filaments) that branch irregularly, often at right angles

3. **Components of the "Theatre of Activity"**

Modern 2026 research often defines the microbiome not just by the organisms themselves (**microbiota**), but by their entire "theatre of activity":

- **Metabolites:** Chemical byproducts like **short-chain fatty acids (SCFAs)**—such as butyrate and acetate—which provide energy for gut cells and regulate the immune system.
- **Genetic Material:** The collective genome of these microbes contains over **3.3 million genes**, which is roughly 150 times more than the human genome.
- **Structural Elements:** This includes the protective **mucus layer** (mucin gels) where many of these microbes reside and interact with the human body

Some additional snippets

It is now known that women pass on their gut and body biome to their babies during the passage through the birth canal and in their breast milk. Allergies and autoimmune dysfunctions are found to be more common in babies born by cesarean section.

A smart underwear device has been created by scientists at the University of Maryland which monitors the frequency of flatulence and hydrogen concentration in the hope of more accurately setting the baseline of what is typical.