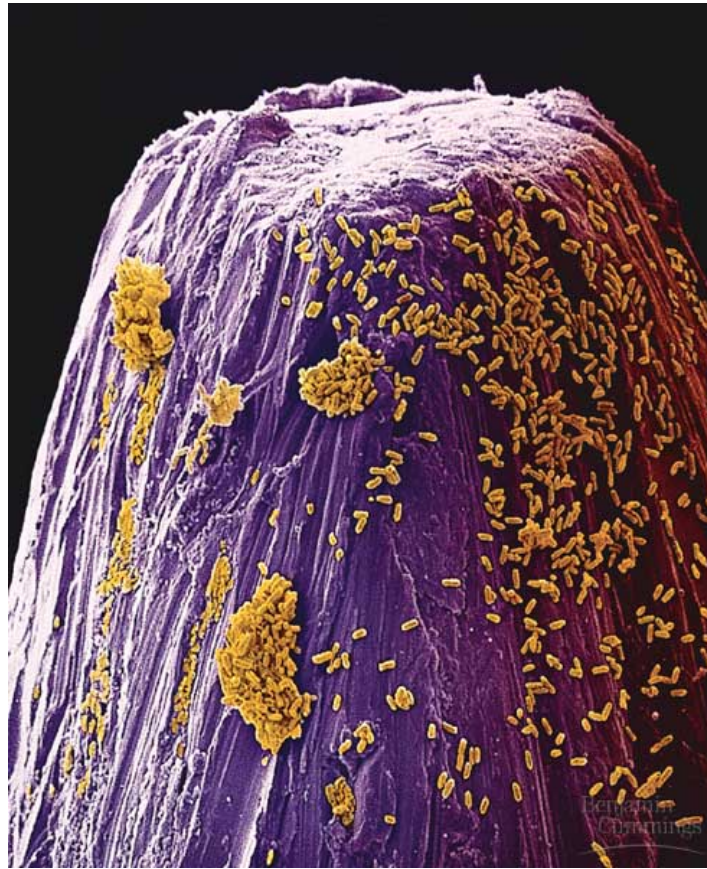


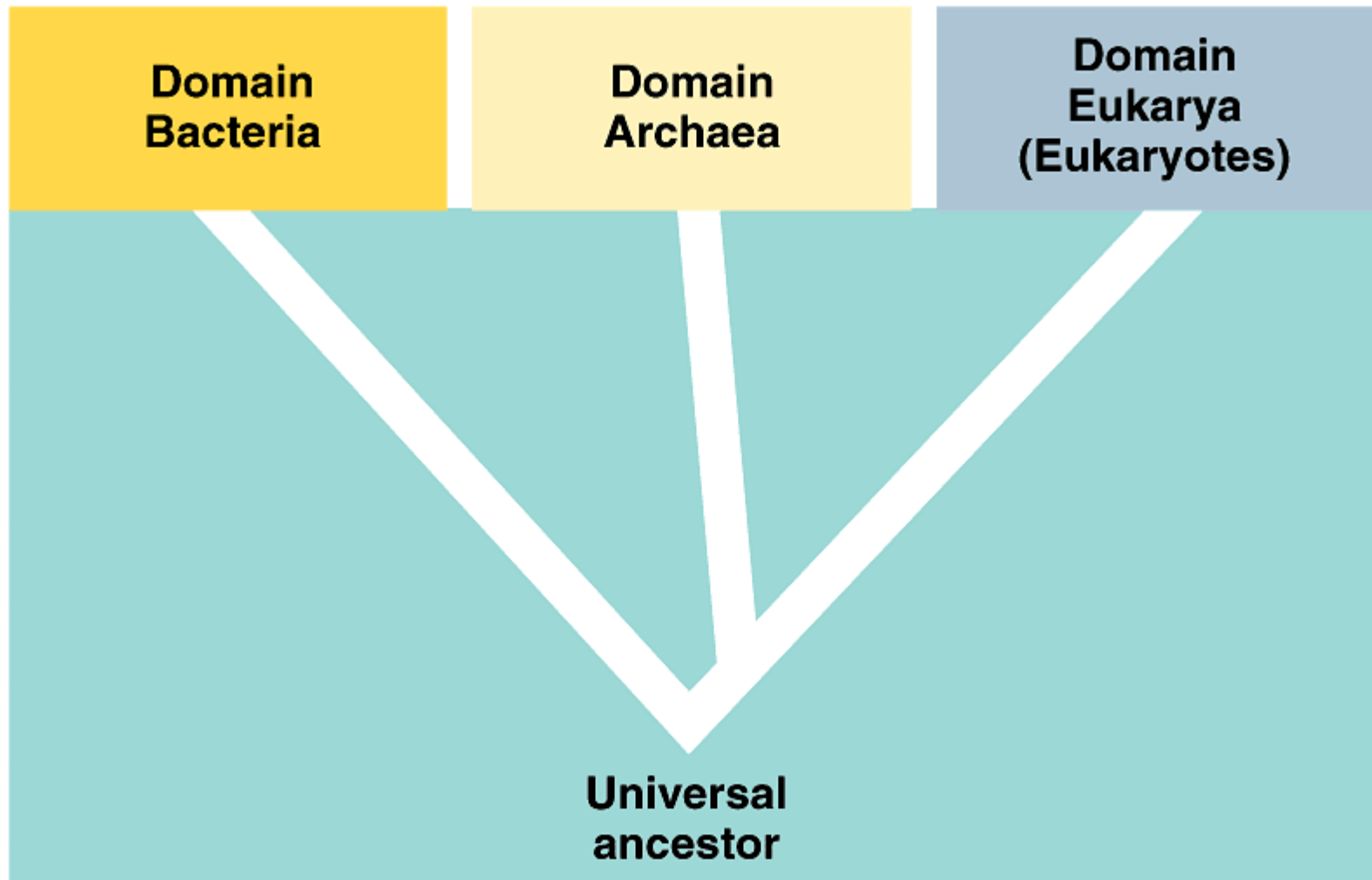
Characteristics of life

- Organization
- Homeostasis
- Reproduction and heredity
- Growth and development
- Metabolism
- Interactions with environment
- Adaptation

Kingdoms Eubacteria and Archaeabacteria

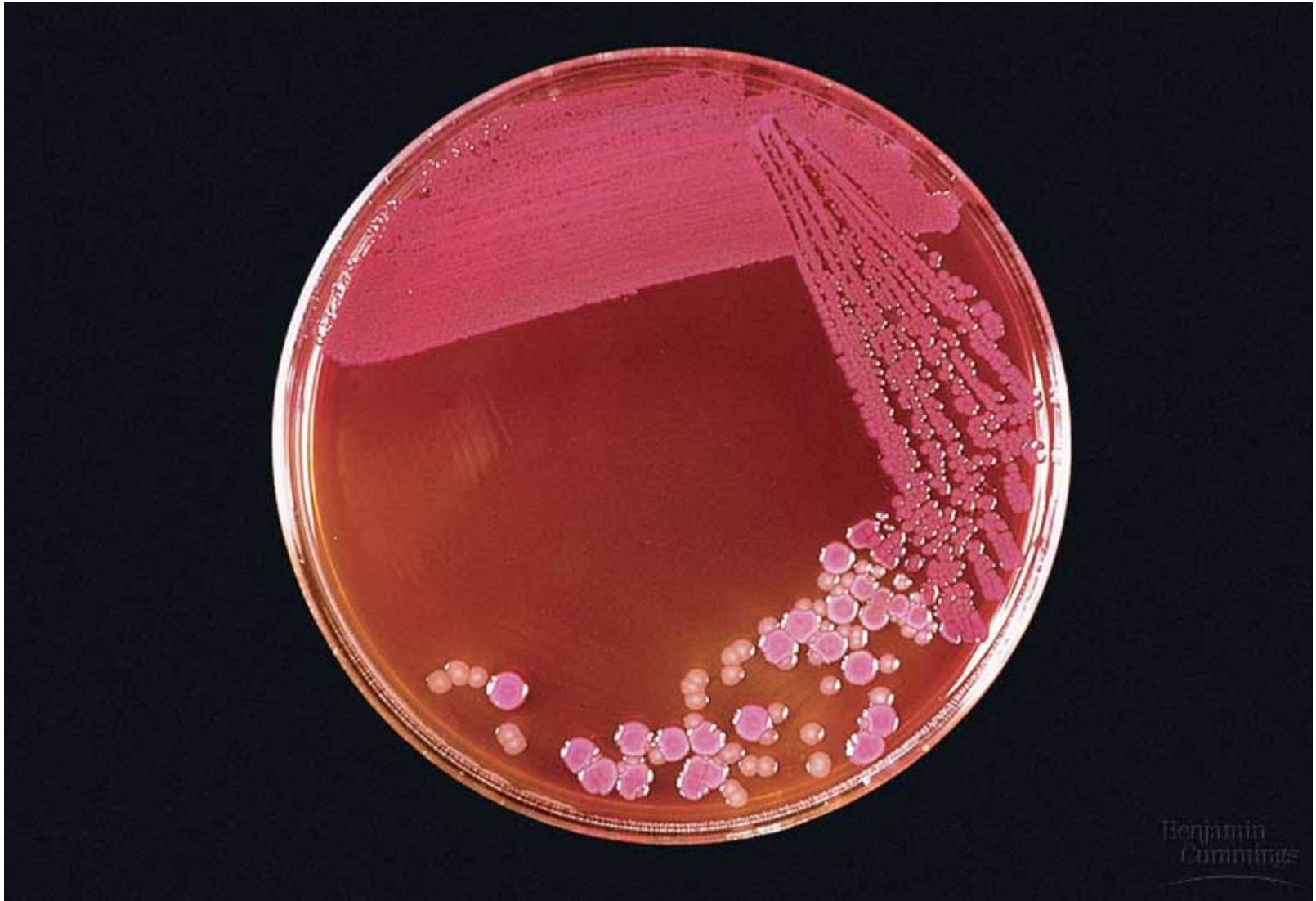


Bacteria at tip of a pin

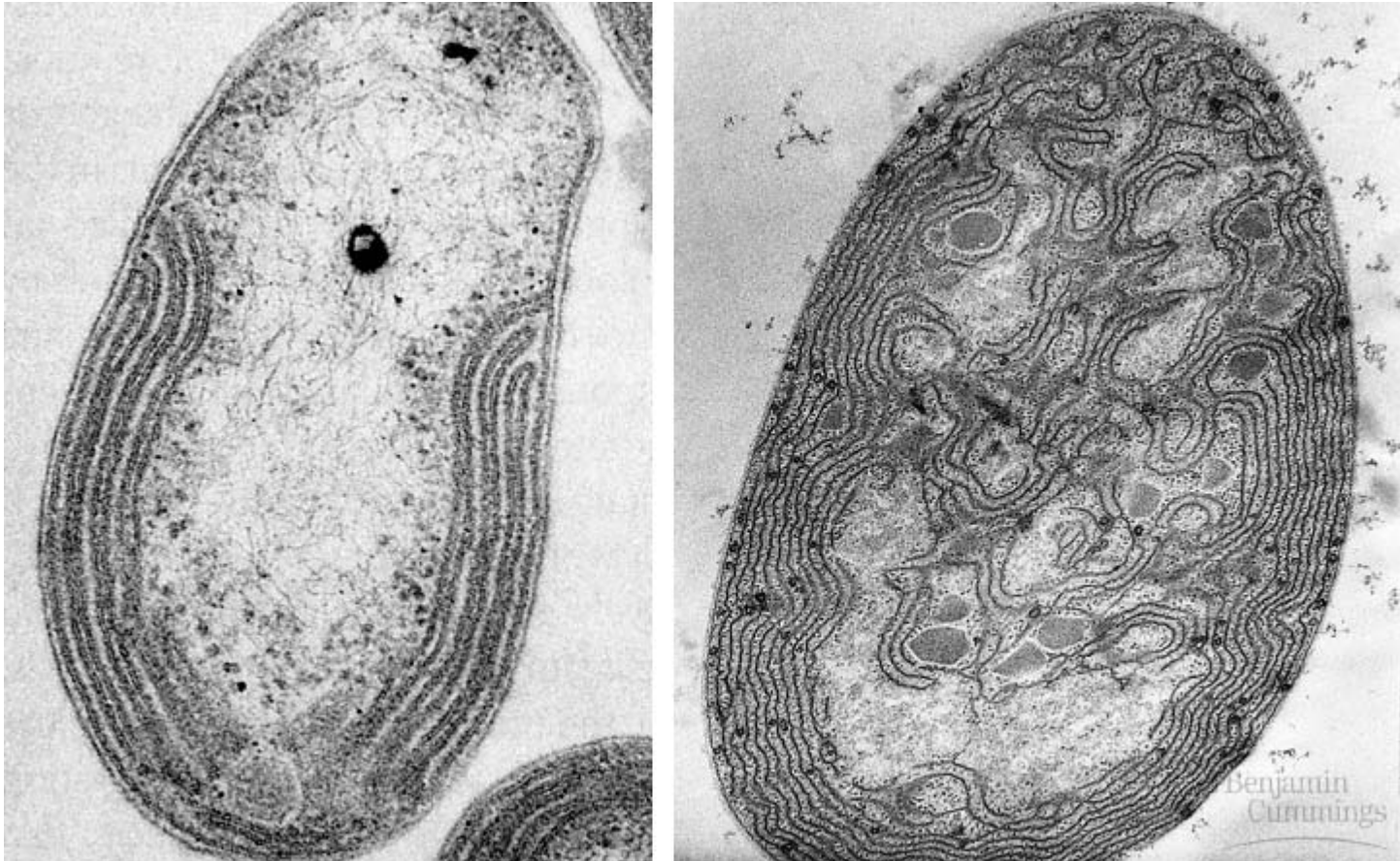


Organization

- Most are unicellular; some eubacteria form colonies
- No nucleus; no organelles, some w/specialized membranes
- Common shapes are spheres (cocci), rods (bacilli), and helices (spirilla and spirochetes)
- Size: 1-5 μm ; largest one 0.75 mm

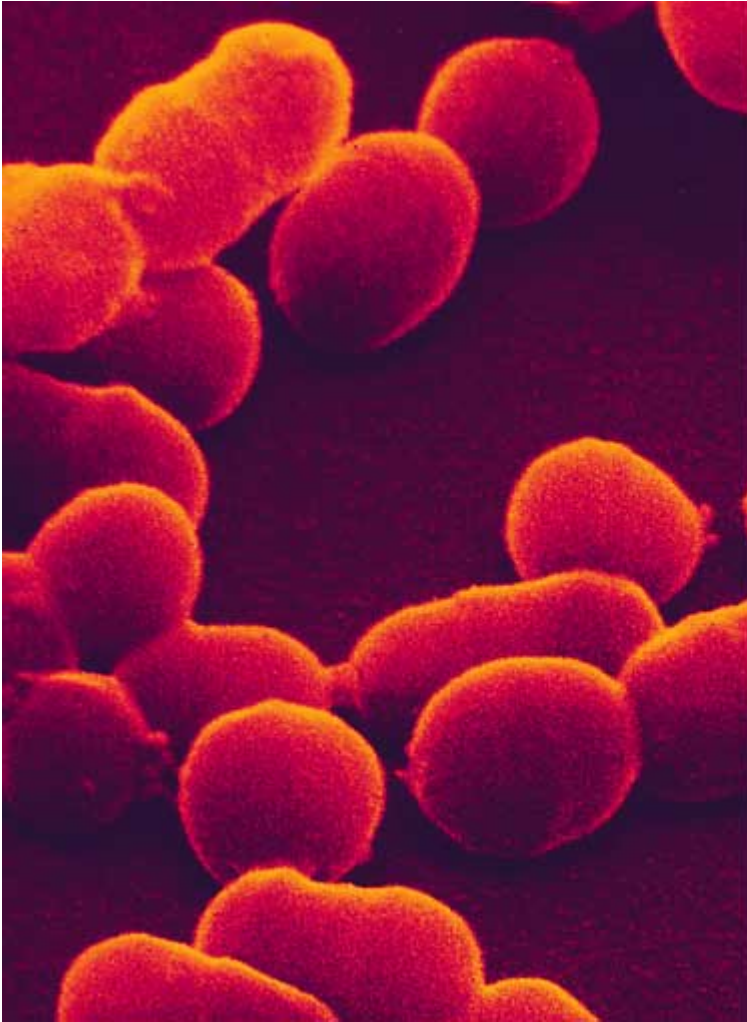


Bacteria colonies

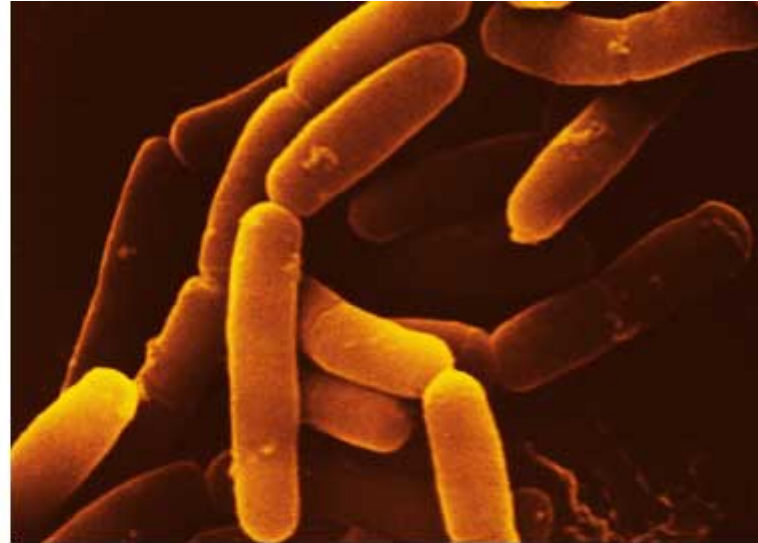


Membranes in bacteria

bacilli



cocci



spirilla



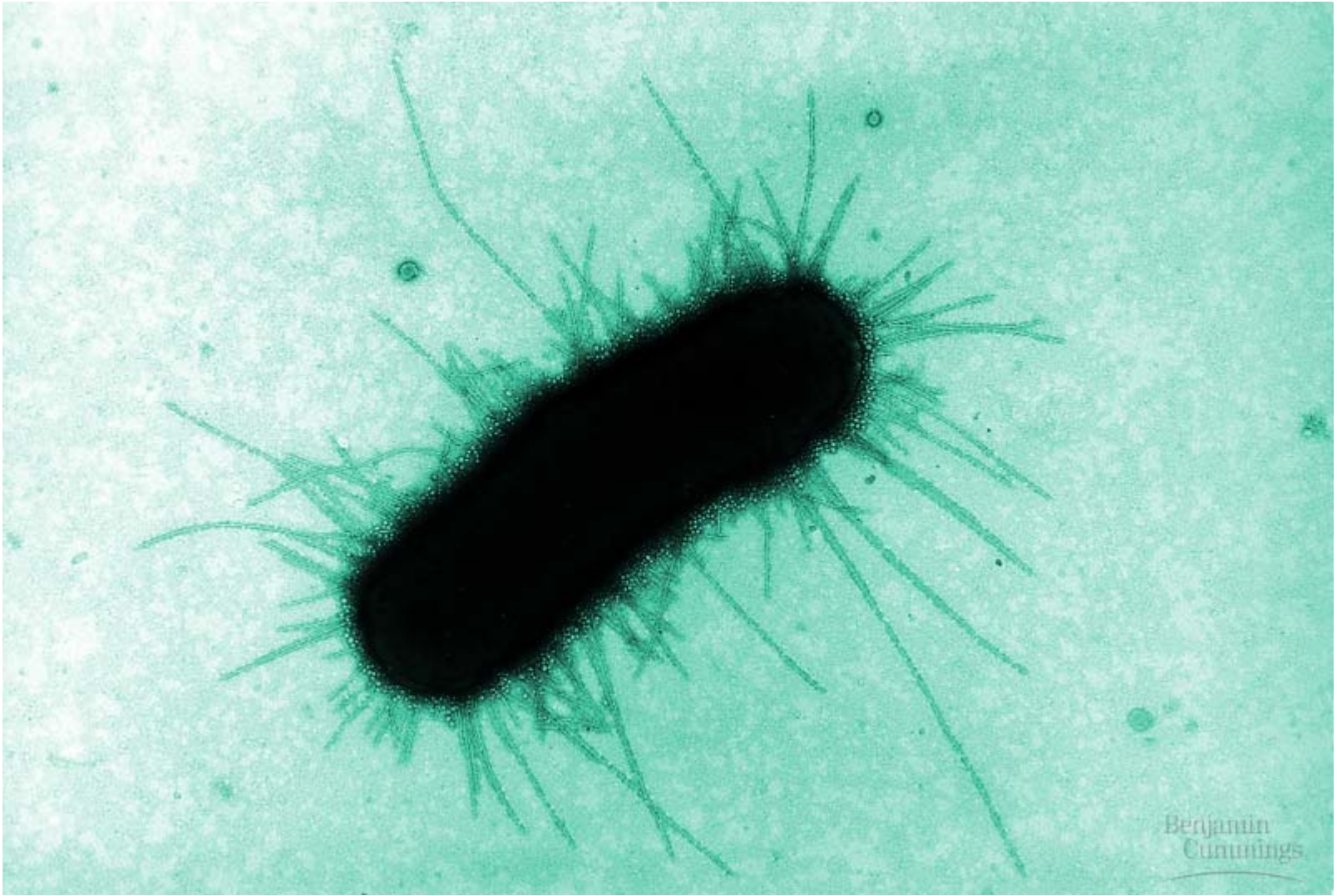


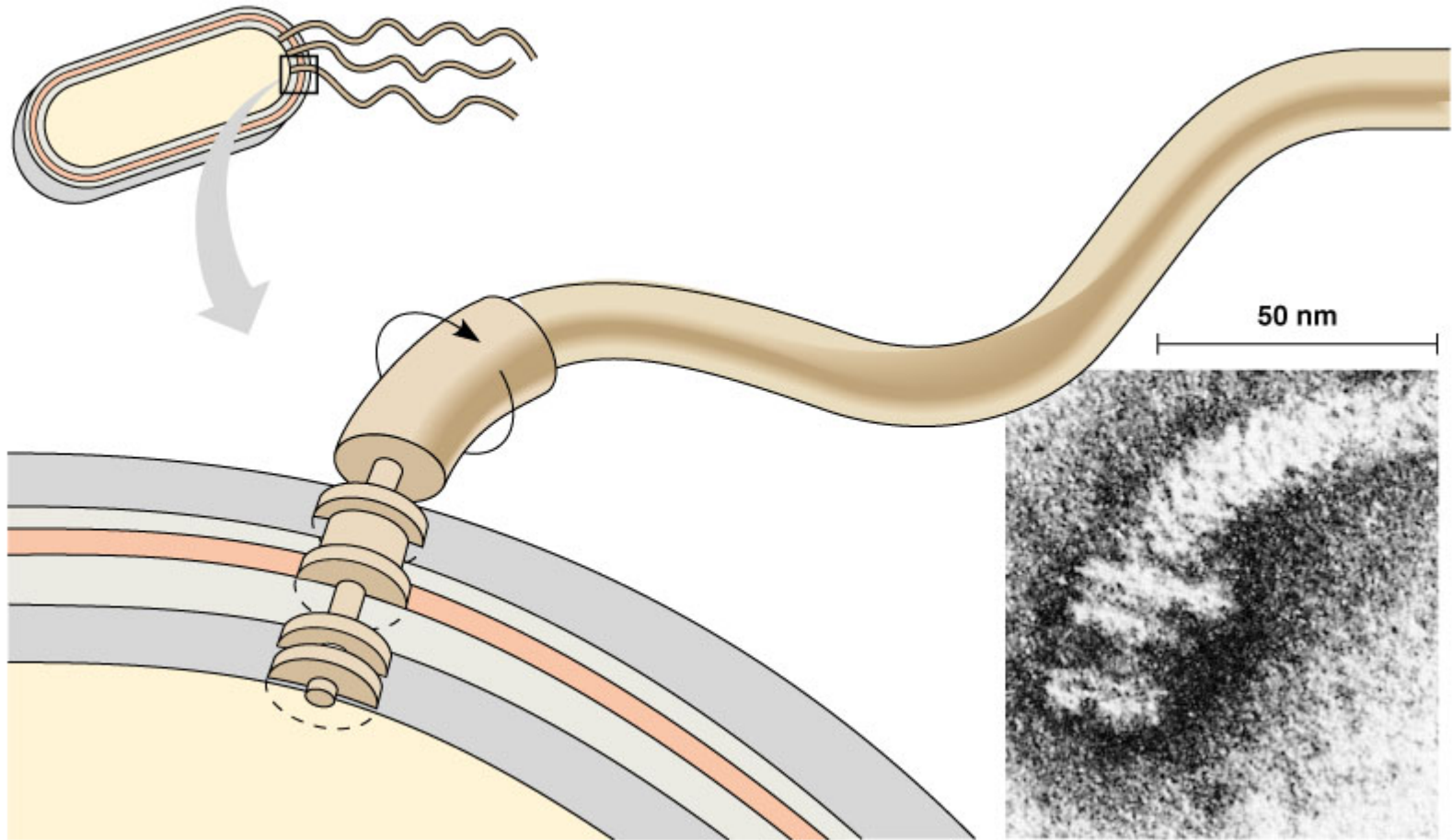
Marine bacterium *Thiomargarita namibiensis*

Homeostasis

- Cell wall
 - Material: Peptidoglycan in eubacteria; no peptidoglycan in archaeabacteria (like eukaryotes)
 - Amount of peptidoglycan defines Gram stain. Large amount Gram-positive; low amount Gram-negative
- Capsule
- Pili
- Flagella
- Endospore

Bacilli with pili





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Diagram of flagella

An anthrax endospore

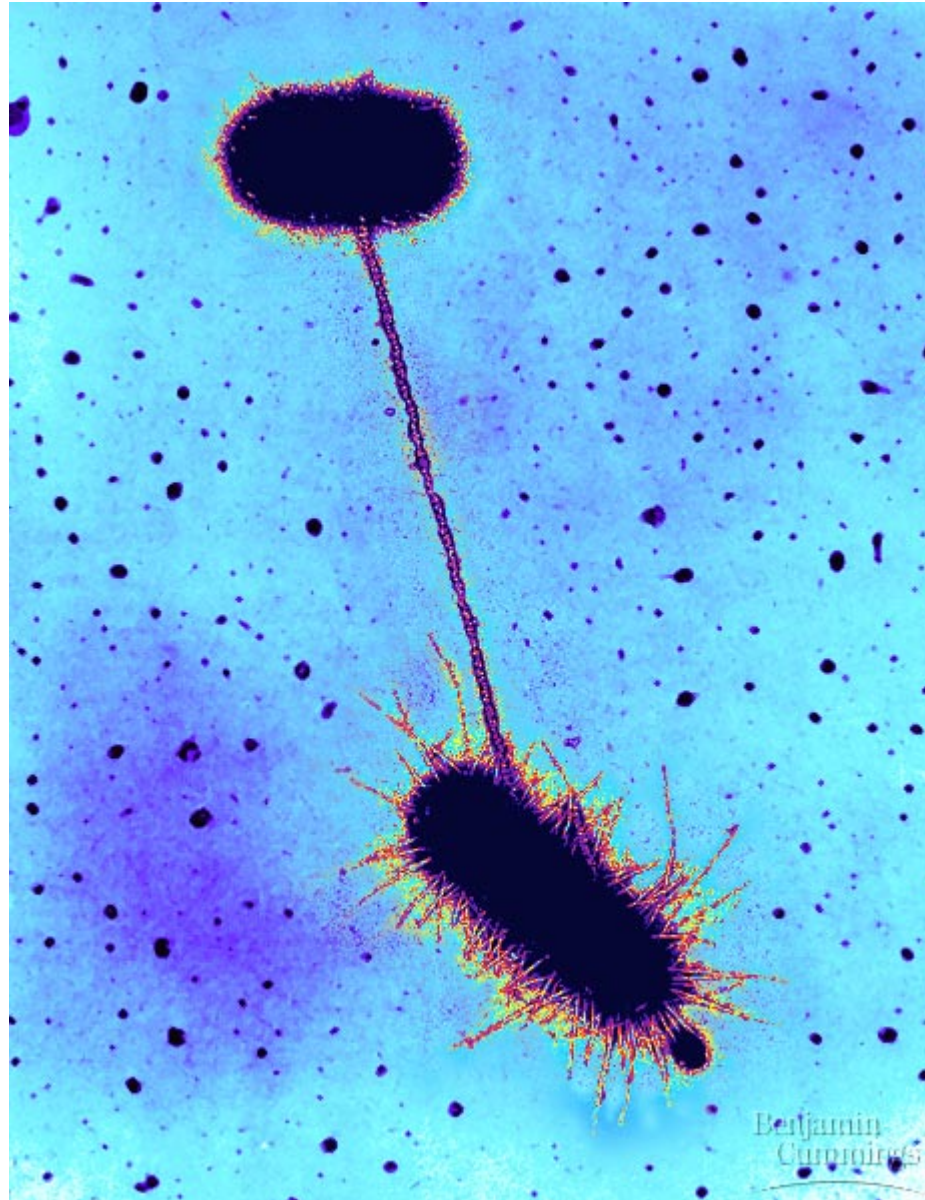


Reproduction and heredity

- Single circle of DNA; no histones associated to DNA in eubacteria but they are observed in archaeobacteria as in eukaryotes; some prokaryotes have plasmids; DNA replication similar to eukaryotes
- No sexual reproduction; not known in archaea
- Binary fission; no mitosis or meiosis
- Gene transfer through:
 - Transformation
 - Conjugation
 - Transduction
- Mutation: main source of genetic variation

Conjugation between two bacteria cells

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Growth and development

- In prokaryotes, the word growth mainly applies to multiplication of cells and increase in population size
- Generation times of 1-3 hours; some of 20 minutes

Metabolism

Classification based on energy and carbon sources

- Photoautotrophs: they use light as energy and CO₂ as carbon source; e.g. cyanobacteria; in prokaryotes and photosynthetic eukaryotes
- Chemoautotrophs: use energy from inorganic chemicals and CO₂ as carbon source; e.g. nitrifying bacteria; only in prokaryotes
- Photoheterotrophs: use light as energy and organic compounds as carbon source; e.g. *Heliobacteria*; only in some prokaryotes
- Chemoheterotrophs: use organic molecules as energy and carbon source; e.g. *Eschericia coli*; widely found in bacteria and eukaryotes

Metabolism cont.

- Prokaryotes vary on their use of O_2 for cellular respiration (degradation of organic compounds in cell to generate ATP)
 - Obligate aerobes. Only use O_2
 - Facultative aerobes. Can use O_2 or engage in fermentation
 - Obligate anaerobes. Are poisoned by O_2 . Engage in fermentation or anaerobic respiration (cellular respiration powered by inorganic chemicals other than O_2)

Ecology

- Highly abundant: *Prochlorococcus* found at 70,000-200,000 cells p/ml of seawater
- Ubiquitous: up to 1500 m below Earth's surface, in oceans from the surface to depths of 10,000 m; temperature range: 0-110°C
- Highly diverse: in human mouth up to 500 spp
- Conditions for optimal growth (T, pH, salt concentrations, nutrient sources) vary across spp
 - Most spp are highly specialized: *Lactobacillus*, methanogens, extreme halophiles, extreme thermophiles
 - Some species are generalists: *Escherichia coli*, nitrogen fixing cyanobacteria

Extreme halophiles

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Ecology cont.

- Competition is high among bacteria spp. They use antibiotic to inhibit growth of other spp
- Symbiotic with many species from other taxa (domains)
 - Mutualism: nitrogen fixing bacteria, *Rhizobium*
 - Comensalism: bacteria living on human skin
 - Parasitism: Pathogens like *Streptococcus pneumoniae*, *Clostridium botulinum*, *Salmonella*

Bioluminescence caused by chemical reaction of symbiotic bacteria



Adaptation

- High capacity for adaptation to new environments
 - Mutation can be rapidly propagated through offspring since generation times are quite fast
 - Populations can adapt quickly to novel environments through natural selection

Importance

- Prokaryotes are indispensable links in the recycling of chemical elements in ecosystems
- Cause of human diseases
- Used in bioremediation
- Metabolic factories for commercial products
- Great systems for molecular and biochemical research

Phylogeny of prokaryotes

