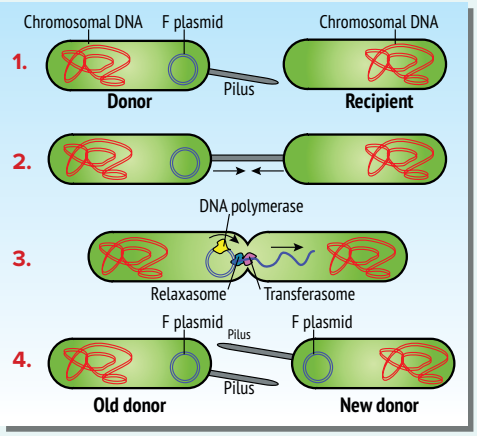
- **Conjugation** sends DNA from one bacteria to another through a **pilus**, usually encoded by a DNA **plasmid** (small, self-replicating, circular DNA)



Asexual Fungal Replication

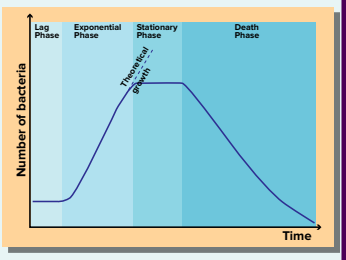
- **Fission:** One cell grows larger and splits evenly
  - **Budding:** The larger cell extends a bubble that gets pinched off
  - **Chlamydospores** form under dry conditions when hyphae swell and form a thick wall
- **Arthrospores** form when hyphae break apart into tube-like structures
- **Conidospores** form on stalks which are then pinched off
- **Sporangiospores** form in a large sac (**sporangium**)

Sexual Fungal Reproduction

1. Requires two **mating types** (*a* and α, also called + and -)
2. Both mating types usually grow as haploids
3. Haploids then fuse, producing a diploid spore-forming cell
4. The diploid cell undergoes meiosis and releases haploid spores in one of several types
   - **Basidospores** cling to the edges of a spore forming unit (**basidium**)
   - **Ascospores** form in a sac within a larger structure (**ascocarp**)
   - **Zygospores** form from the fusion of two hyphae of opposite mating types
   - **Oospores** are formed from the fusion of mating-type-specific **oogonium** and **antheridium**

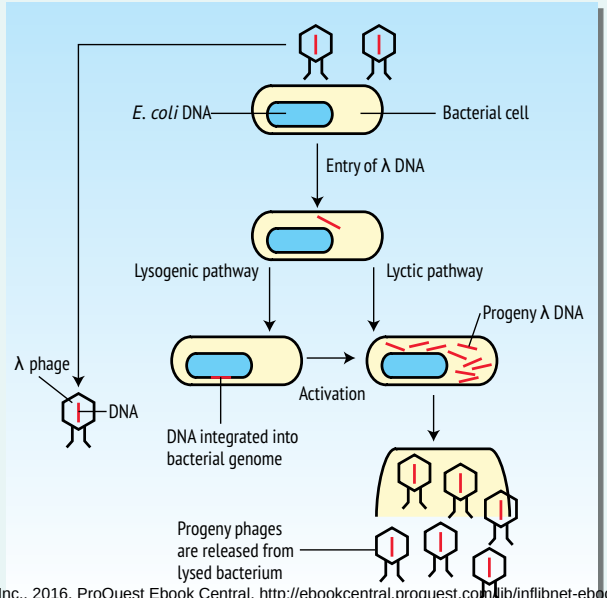
Microbial Growth Phases

- **Lag phase:** Very slow growth of bacteria from a low initial number while they are adapting to growth conditions
- **Exponential/Log phase:** Rapid increase in bacterial concentration; they more or less double every cycle
- **Stationary phase:** Stable concentration of organisms caused by a depletion of nutrients and/or accumulation of toxins; birth and death rates are approximately equal
- **Death phase:** Organism concentration decreases; cells die and media can no longer support survival
  - **Synecological culture:** True to nature conditions; requires multiple types of microbes to be present
    - Microbes usually do ***not*** grow to media exhaustion
    - Complex system in which various microbes interact with each other and affect each other's growth
    - Many bacterial species may require this type of culture to be cultivated at all



Viral Replication

- Genetic material may be **single-stranded DNA**, **double-stranded DNA**, **single-stranded RNA**, or **double-stranded RNA**
- DNA strands are replicated by the host cell DNA polymerases
- RNA strands are either:
  - Copied directly using **RNA-dependent RNA polymerase**
  - Copied into DNA first using **reverse transcriptase**
- RNA polymerases and reverse transcriptases lack **proofreading**, so RNA viruses mutate faster
- **Fusion:** For membrane-bound viruses only, the viral membrane joins to the host cell membrane
- **Endocytosis:** Capsid and genetic information is brought into the cell by surrounding the virus with a membrane layer from which the virus later escapes
- **Genetic injection:** A virus capsid opens up the cellular membrane and transfers genetic information directly into the cytoplasm
- **Lysogenic** viruses take up residence in the host cell (often hiding in the cell's DNA) and replicate rarely if at all until a triggering event causes the lysogenic stage virus to enter the lytic stage
  - **Lytic** viruses immediately start to replicate in the host cell and usually kill the host cell in a few hours
- Reverse transcriptase allows RNA viruses such as HIV to join cellular DNA



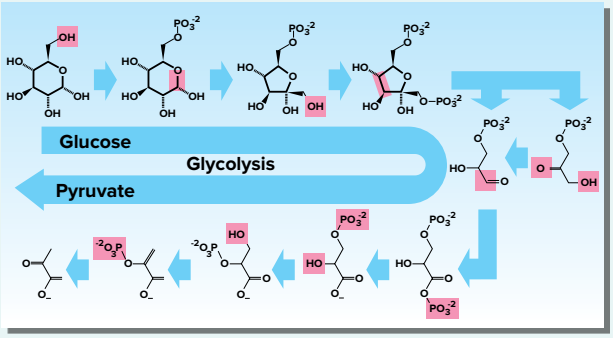
Metabolism

Energy Sources

- **Photoautotrophs** use light to store energy via photosynthesis
- **Chemoautotrophs** use chemical energy from molecules (e.g., H_2S and NO_3^-) to store energy; these molecules are found in places such as deep sea vents
- **Photoheterotrophs** use light energy to make key organic compounds (e.g., cyanobacteria fixing N_2 gas)
- **Chemoheterotrophs** use chemical energy alone to live on (e.g., fungi and molds)

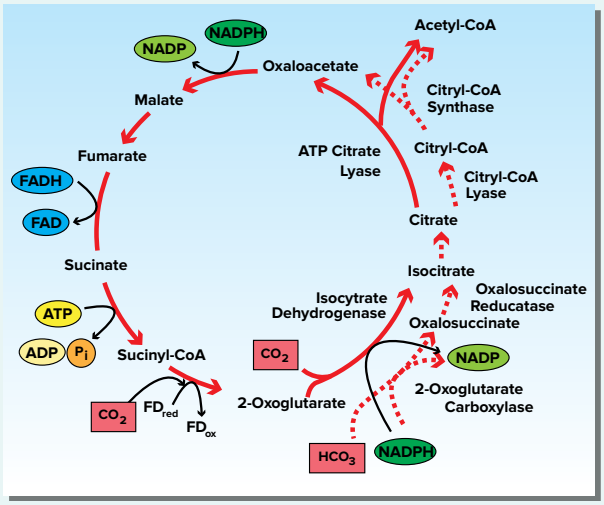
Glycolysis & Gluconeogenesis

- When the cell needs energy, glucose is converted into two molecules of pyruvate
- When a cell has extra energy, pyruvate or glyceraldehyde-3-phosphate is made into glucose
- Any six-carbon sugar used for energy gets converted into glucose or fructose



Fermentation or Krebs Cycle?

- In **aerobic conditions** (i.e., with oxygen gas), more energy is extracted through the Krebs cycle
  - CoA + Pyruvate + NAD^+ ------> Acetyl CoA + NADH + CO_2



- Under **anaerobic conditions**, NADH must be recycled into NAD^+ without more energy being extracted. Pyruvate + NADH becomes:
  - Lactic acid + NAD^+ in muscles and *lactobacillus* (lactic acid fermentation)
  - Ethanol + CO_2 + NAD^+ in yeasts and most bacteria, brewing, and baking (alcoholic fermentation)
  - Formic, succinic, and acetic acids + NAD^+ + (sometimes) CO_2 in mixed acid fermentation; usually several are produced at once
  - Propionic acid + NAD^+ in ruminants and bacteria from sweat glands

Electron Transport Chain

- Energy from NADH and $FADH_2$ of the Krebs cycle is used to move H^+ ions across a membrane
  - In the mitochondria of eukaryotes, the membrane is the inner mitochondrial membrane
  - In prokaryotes, the cell membrane is used
  - In all cases, the H^+ gradient is used to synthesize ATP using an F-type ATPase (**oxidative phosphorylation**)
- Electrons move from NADH to molecular oxygen (O_2), the final electron acceptor