Cells Eukaryotes and Prokaryotes

Life - Eukaryotes and Prokaryotes

Introduction

This current page is the science lecture Medicine Foundations 2014 Lecture Link

This lecture introduces the cell as the unit of life. Firstly, by the methods we use to see cells and biological structures and what we consider to be "alive". Then by looking at major differences between cell types and their organisation as unicellular or multicellular organisms. Finally, the presence or absence of a nucleus which is the definition of the major 2 classes of cells.

(Greek, \textit{Karyose} = kernel, as in a kernel of grain)

Archive


Objectives

- Introduction to biological molecules
- Understand the dimensions cells
- Understand differences between prokaryotes and eukaryotes
- Understand differences between unicellular and multicellular organisms
- Brief understanding of viruses and prions

About Human Body

Human Cells

- 210+ cell types in body
- total number of estimated cells in the body - $10^{13}$ (American Ten trillion/British Ten billion)

Flora
bacteria, fungi and archaea
found on all surfaces exposed to the environment
- skin and eyes, in the mouth, nose, small intestine
- most bacteria live in the large intestine

- 500 to 1000 species of bacteria live in the human gut
- total number of estimated flora ten times as many bacteria $10^{14}$ (American One hundred trillion/British One hundred billion)

**Cell Sizes**

- frog or fish egg are the largest individual cells easily visible, approx 1+ mm diameter
- human or sea urchin egg, approx 100 micron (µm) diameter
- typical somatic cell, approx 20 micron diameter
- plant cells are larger, approx 30 x 20 micron
- bacteria are smaller, approx 2 x 1 micron

**Divisions of Life**

**Prokaryotic**

- bacteria and archaea (single-celled microorganisms previously called archaeabacteria)
  - no cell nucleus or any other organelles within their cells
  - organisms that can live in extreme habitats
  [http://www.ucmp.berkeley.edu/archaea/archaea.html](http://www.ucmp.berkeley.edu/archaea/archaea.html)

**Eukaryotic**

- plants
- animals
- fungi
- protists


**Unicellular and Multicellular**

**Unicellular**

- All prokaryotes and some eukaryotes
  - Yeast + budding, non-budding
  - Protozoa + classified by means of locomotion: flagellates, amoeboids, sporozoans, ciliates + often "feed" on bacteria

**Multicellular**

- Eukaryotes
- Plants and Animals
- Allowed development of specialized cells
- functions and tissues

**Prokaryote**
Bacterial morphologies

- bacteria are smaller, approx 2 x 1 micron (1x10^-6 m)
- not all bacteria are dangerous or disease causing

(MH - the adult human in addition bacteria to the skin surface and lining of the respiratory/digestive tract, also has intestines contains trillions of bacteria made up from hundreds of species and thousands of subspecies)

- biochemically diverse
- simple structure, classified by shape (rod-shaped, spherical or spiral-shaped)
- some prokaryotic cells have also been shown to have a "cytoskeleton", which is different from eukaryotic cells.
Bacteria morphology

Prokaryotic Motility

Some bacteria are highly motile and there are differing mechanisms of motility.

- **Swimming**
- **Twitching**
- **Flagellation**
- **Globulation**

flagella motility spiral bacteria

Prokaryotes Cell Wall

- **Bacterial Shape** - Bacterial shapes and cell-surface structures
- **Bacterial Membranes** - A small section of the double membrane of an E. coli bacterium
  - Bacterial outer membranes - outer membrane contains porins
  - Bacterial cell walls - Bacterial cell walls (http://water.me.vccs.edu/courses/ENV108/clipart/cellwall.gif)
    - **Gram-negative** bacteria surrounded by a thin cell wall beneath the outer membrane
    - **Gram-positive** bacteria lack outer membranes and have thick cell walls

(MH - note that some unicellular eukaryotes can also have a cell wall)


Molecular Biology of the Cell


Medical Microbiology
Prokaryote Division

- Bacterial Replication - DNA replication and cell division in a prokaryote
- MCB - DNA replication and cell division in a prokaryote

Prokaryote Mycoplasmas

- smallest self-replicating organisms
- smallest genomes (approx 500 to 1000 genes)
- spherical to filamentous cells
- no cell walls
- surface parasites of the human respiratory and urogenital tracts
  - *Mycoplasm pneumoniae* infect the upper and lower respiratory tract
  - *Mycoplasm genitalium* a prevalent sexually transmitted infection
  - *Mycoplasma hominis* associated with bacterial vaginosis and pelvic inflammatory disease
  - *Mycoplasma hyorhinis* found in patients with AIDS

Prokaryote "Cytoskeleton"

- E. coli FtsZ
- Mycoplasma hominis infected Hela cells
Prokaryotic and Eukaryotic Cells

The following links describe the major differences between prokaryotic and eukaryotic cells, the way they divide and the way in which antibiotics have their action on prokaryotic cells.

- **The Cell- A Molecular Approach**

- **Molecular Cell Biology**
  - Figure 12-6. DNA replication and cell division in a prokaryote ([source](http://www.ncbi.nlm.nih.gov:80/books/bv.fcgi?db=Books&rid=mcb.figgrp.3176))

- **Biochemistry**
  - Figure 28.15. Transcription and Translation ([source](http://www.ncbi.nlm.nih.gov:80/books/bv.fcgi?db=Books&rid=stryer.figgrp.3980)) two processes are closely coupled in prokaryotes, whereas they are spatially and temporally separate in eukaryotes.

Plant Cell

- plant cells are larger than mammalian cells approx 30 x 20 micron
- Additional Organelles
  - Central Vacuole
    - tonoplast maintains cell's turgor
    - storage (water, ions, and nutrients such as sucrose and amino acids, and waste products)
- Plastids
  - organelles found in plants and algae
  - chloroplasts for photosynthesis
  - Amyloplasts for starch storage
  - Chromoplasts for pigment synthesis and storage
  - Leucoplasts - can differentiate into more specialized plastids (Amyloplasts - starch storage, Elaioplasts - storing fat, Proteinoplasts - storing and modifying protein)
  - (MH - plastids and mitochondria and have own DNA)
- **Cell Wall**
  - Rigid structure outside cell membrane
  - No ability to move
  - Resist osmotic stresses
  - Structure - cellulose, hemicellulose, pectin

- **Specialized Adhesion Junctions**
  - plasmodesmata
  - cell-cell communication pathways
  - allow cell membrane and endoplasmic reticulum of adjacent cells to be continuous


**Chloroplasts**

- disk-shaped and about 5-8 µm in diameter and 2-4 µm thick. A typical plant cell has 20-40 of them.

**Animal and Plant Cell**

**Virus**

- **Dengue virus**
- **Herpes virus**
- **Zika virus**
not a cell Latin, *virus* = toxin or poison
- not alive
- infects living cells
- unable to grow or reproduce outside a host cell
- Infect different hosts (animal, plant and bacterial)
- Classified
  - RNA or DNA viruses
  - double or single stranded

**Virion**
- contains the genetic material, DNA or RNA
- within a protective protein coat (capsid)

**Bacteriophage**
- A virus that infects bacteria

**Molecular Cell Biology**
- NPR - Virus Infection (http://www.youtube.com/watch?v=Rpj0emEGShQ&feature=PlayList&p=49AA6FE8E2B8C71F&index=1)

**Prion**
- not alive
- an infectious prion protein
- misfolded normal protein (three-dimensional structure)
- can form aggregates
- Types
  - Creutzfeldt-Jacob disease (CJD) and Kuru a human neural prion disease
  - Bovine spongiform encephalopathy (BSE) in cattle, "mad cow disease"
  - Scrapie in sheep


**Biological Levels**
Whole cell
Organelles (nucleus, mitochondria, ER, Golgi)
Components
Biological polymers (chains of molecules, consisting of monomer subunits)
- DNA, RNA, Protein, sugars, cellulose
Organic molecules (monomer subunits)
- nucleotides, amino acids, carbohydrate

Eukaryotic Cell Organelles

- Fundamental concept - all cells
  - Specialized exceptions
- Organelle
  - specialized part of a cell that has its own particular function
  - Membrane bound (enclosed)
  - forms "compartments" within the cell

Next Lecture

- Cell Compartments and Membranes
  - Metabolic and biochemical “specialization”
  - Localization of function
  - Import and export
  - Regulation of transport
  - Detection of signals
  - Cell-cell communication
  - Cell Identity
  - Cell membrane - plasma membrane, plasmalemma
  - Organelle membranes - basic structure similar

References

Textbooks

- Molecular Biology of the Cell
  - Some Important Discoveries in the History of Light Microscopy
  - The evolution of higher animals and plants (Figure 1-38)
  - From Prokaryotes to Eucaryotes
  - From Single Cells to Multicellular Organisms
  - Some of the different types of cells present in the vertebrate body

- Molecular Cell Biology

- The Cell- A Molecular Approach

Search Online Textbooks

Books

- Plant Cell Vacuoles (http://books.google.com/books?id=KIbyPQIHG50C) By Deepesh Narayan De, CSIRO (Australia)

Reviews

Internal Links

- ANAT3231 Cell Biology
- Course Timetable
- 2009 Student

External Links

- American Society Cell Biology (http://www.ascb.org/)
  - The Nobel Prize in Physiology or Medicine - Laureates (http://www.nobel.se/medicine/laureates/)
- Berkeley History
  - Robert Hooke (1635-1703) (http://www.ucmp.berkeley.edu/history/hooke.html)
  - Antony van Leeuwenhoek (http://www.ucmp.berkeley.edu/history/leeuwenhoek.html)
- Theodor Schwann (http://home.tiscalinet.ch/biografien/biografien/schwann.htm)
- Museum of Microscopy (http://microscopy.fsu.edu/primer/museum/)

2016 Course Content


Laboratories: Introduction to Lab | Microscopy Methods | Preparation/Fixation | Cell Knockout Methods | Cytoskeleton Exercise | Immunochemistry | Project Work | Confocal Microscopy | Tissue Culture | Stem Cells Lab | Microarray Visit

Template:2016 Projects

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