












- 1  **ANAT3231 - Cell Biology  
Lecture 4**  
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- 2  **UNSW Copyright Notice**
- 3  **Lecture 4 Overview**
  - Cytoplasmic Organelles
    - Lysosomes
    - Peroxisomes
    - Mitochondria
  - Nucleus
  - Structure and function
  - abnormalities
- 4  **Compartments**
- 5  **Golgi Apparatus (fl)**
- 6  **Cell Organelles 2**
  - Exocytosis
    - protein export
  - Endocytosis/Phagocytosis
    - protein/substance import
    - detoxification
    - digestion
  - Energy Production
    - mitochondria, chloroplasts
- 7  **Endocytosis**
- 8  **Movie: Endosomes**
- 9  **Movie: Phagocytosis**
- 10  **Oxidation & Digestion**
  - Peroxisomes
    - probably replaced by mitochondria as they produce Energy
  - Lysosomes
    - Both single membrane bound vesicles linked to the ER and Golgi membrane system
- 11  **Lysosomes and Peroxisomes**

- Cell fractionation by biochemists (1955)
  - Nuclear
  - Mitochondrial
  - Microsomal
  - Supernatant
- 1974 Nobel Prize
  - “structural and functional organization of the cell”
    - <http://nobelprize.org/medicine/laureates/1974/index.html>

## 12 Peroxisomes

## 13 EM: Peroxisomes

- increased the activity of digestion in enzyme studies
- Identified by EM 10 years later
- oxidative reactions using molecular oxygen to generate hydrogen peroxide
- Catalases

## 14 Peroxisome Assembly

## 15 Lysosomes

- Are the site of cellular digestion
- contain up to 40 enzymes for digestion
- Acid Hydrolases
  - Active at acid pH (5)

## 16 Digestive Enzymes

- Acid hydrolases
  - protease
  - nuclease
  - glycosidase
  - lipases
  - phospholipases
  - Phosphatases

## 17 Lysosome Types

- Primary
  - newly formed without digestive substrate
  - formed from budding Golgi apparatus
- Secondary
  - the active form
  - enzyme + substrate

## 18 Lysosomes

## 19 Lysosomes

## 20 Lysosome Membrane

- allows passage of uncharged molecules

- upon entry molecules are charged and cannot leave
- lysosome-associated membrane proteins
  - LAMP-1, LAMP-2
  - Knockout of LAMP-2 in mice
    - lysosomal enzyme targeting, autophagy and lysosomal biogenesis
    - LAMP-2 deficiency in humans leads to Danon disease
      - a fatal cardiomyopathy and myopathy
      - OMIM <http://www.ncbi.nlm.nih.gov/entrez/dispomim.cgi?id=300257>

## 21 Lysosomal Disorders

- Several inherited disorders of lysosomal metabolism
  - OMIM Database 112 entries
- Lack of a specific enzyme
- Can isolate and measure enzyme activities

## 22 Double Membrane Organelles

- Nucleus
  - All eukaryotes
- Chloroplasts
  - plants
- Mitochondria
  - plants & animals

## 23 Mitochondria

- Located throughout cytoplasmic compartment
- Ancient aerobic organisms in symbiosis
- Respiratory Chain
  - Energy production
- Apoptosis role
  - Programmed cell death

## 24 Movie- mitochondria

## 25 Mitochondria

- Come in different shapes & sizes
- Can rapidly change shape (minutes)

## 26 EM: Mitochondria

## 27 EM: Mitochondria









## 28 EM: Mitochondria













## 29 Mitochondrial Morphology

## 30 Mitochondrial Location

## 31 Mitochondria and Endoplasmic Reticulum (fl)

## 32 Mitochondria (fibroblasts)

- 33  **Mitochondria (sperm)**
- Packed around initial segment
  - Energy for sperm motility
    - Microtubules (9+2)
      - Covered in cytoskeleton lecture
  - Not incorporated into zygote
    - Maternal only
- 34  **Mitochondria**
- generally located where energy consumption is highest in the cell
  - Example: Muscle, sperm tail, flagella
- 35  **Mitochondria**
- Double membrane
  - Matrix contains genetic material
    - Multiple copies
- 36  **Evolution: Symbiosis theory**
- 37  **Mitochondrial Structure**
- Outer Membrane
    - channel proteins & enzymes
  - Intermembrane space
    - Enzymes that use ATP
  - Inner Membrane
    - Oxidn for respiratory chain
    - ATP synthetase
    - transport proteins (metabolites)
  - Matrix
    - 100s of enzymes
    - mitoDNA
- 38  **Mitochondrial Function**
- 39  **Mitochondrial DNA**
- 40  **Mitochondrial DNA**
- Complete human sequence known (1981)
    - 16,569 nucleotides
    - multiple copies
  - Encodes
    - Proteins
    - RNAs
  - Nuclear DNA encodes many mitochondrial proteins
  - Maternally inherited

- 41  **Mitochondrial Protein Synthesis**
- may have originally been independent
  - proteins synthesized in cytosol and imported into mitochondria
- 42  **Mitochondrial Protein Synthesis**
- Petite mutants
    - all mitochondrion-encoded gene products missing
    - organelle is constructed entirely from nucleus-encoded proteins
- 43  **Mitochondria Division**
- Divide independently of the whole cell
  - Generated by existing mitochondria
  - inward furrowing like bacterial division
    - inheritance?
- 44  **Energy Production**
- Raw Materials
  - Oxygen
  - Pyruvate & Fatty Acids
  - Products
    - Carbon Dioxide
    - Adenosine Triphosphate (ATP)
- 45  **The Nucleus**
- Contains Genetic material
    - Chromosomes
    - DNA + histones
  - Double Membrane
    - Nuclear pores
  - Cytoskeleton
    - Lamins
    - cover in cytoskeleton lecture
  - Selective contents
    - No cytoplasmic organelles
    - No protein synthesis
    - RNA processing
    - Steroidal hormone receptors
- 46  **Nuclear Structure**
- 47  **Nuclear Membrane (em)**
- 48  **Nuclear Membrane/Pore**
- 49  **Nuclear Cytoskeleton**
- 50  **Nuclear Membrane Breakdown**
- 51  **Nuclear Localization Signal (nls)**
- 52  **Nuclear Protein Import/Export**

53  **References**

- ANAT3231 Lecture
  - <http://cellbiology.med.unsw.edu.au/units/science/lecture0504.htm>
  - Audio Recording (iLecture) also available linked from above lecture page
- Essential Cell Biology: chapter 1, 13
- Molecular Biology of the Cell: chapter 12, 14
- The Cell: chapter 8, 10
- Molecular Cell Biology: chapter 11, 16, 17