Molecular basis of inheritance

Thursday, 5 March 2015
2:05 pm

Linus Pauling
- Thought proteins are hereditary material

Griffith
- Live S strain, mouse dead
- Live R strain had no affect
- Heat-killed S strain had no affect
- Live R and heat-killed S, mouse dead

Avery
- Removed lipids, removed RNA, removed proteins
- Only when removing DNA did the mouse survive
- Proved DNA carries genetic information

Watson and Crick
- Proposed double helix structure
- They had the chemical structures of nucleotides
    - DNA sugar has H, RNA sugar has OH (hydroxyl group)
    - A and G have two carbon rings (purines), C and T have one carbon ring (pyrimidines)
- They had Chargaff -- who found that amount A = amount T, amount G = amount C
- They had Franklin's work -- x-ray diffraction pattern

DNA replication is semi-conservative. i.e. daughter DNA contains one parent strand and one replicated strand
5' to 3'
3' to 5'

- Enzymes can ONLY add nucleotides to 3' end
- During duplication, one strand is continuously made (leading strand)
- The other (the lagging strand) is made discontinuously -- they are broken up into Okazaki fragments
- Ligase enzymes join the fragments

Features of DNA
- Stable -- most biological compounds will degrade
- Stable -- it can be fixed through repair
- Encodes a lot of information
- Can replicate itself

Differences RNA and DNA
- Single strained
- U instead of T
- One second carbon: DNA has H, RNA has OH (hydroxyl)

Central Dogma of gene expression*

Protein synthesis: Transcription and translation
- Protein length ranges from 20-1,000 amino acids
- RNA polymerase (like DNA polymerase) cannot add to the 5' end. MUST start at 3' end

- A promoter attaches to the DNA and this signals the RNA polymerase to start work
- Introns are cut out (introns interfere, exons exit the nucleus)
- mRNA into cytoplasm, then attaches to ribosome
- tRNA attracted to ribosome, joins anticodon to mRNA's codon

- Smaller ribosome subunit attaches to mRNA, then a larger ribosome subunit attaches to the complex
- 70S -- small 30S and large 50S sub units

- First tRNA goes into the P site
- All tRNA that follow go into the A site (acceptor site)
- tRNA moves along the sites, and the polypeptide chain attaches to the newest amino acid
- As one enters the A site, one must leave at E site (exit site)

mRNA has three reading frames
- Often, two of the three end abruptly and produce non-functional polypeptides

Practical classes

Sunday, 8 March 2015
6:28 am

The Microscope

- Base should be 5cm from edge of table
- To determine if there is dirt on the:
    - Slide, move the slide -- dust stays relative to image
    - Eyepiece, rotate the eyepiece -- dust rotates
    - Objective lens, replace objective lens -- dust disappears
- Lenses to be cleaned with lens cleaning tissues and 70% ethanol

<u>Reference :</u>
Peat et al. Biology skills for undergraduate students
See Seeley, sections
- 2.1
- 2.4
- 3.1
- 3.2
- 3.7
- 3.9

Iris diaphragm?? Condenser??

Cell structures and functions

Monday, 9 March 2015
12:01 pm

- Describe the structures (and functions) of a cell
- Understand surface area to volume ratios in relation to cells
- Describe the structure of DNA and how it replicates
- Describe the stages of the cell cycle

Atoms > molecules > cells > tissues > organs > organ systems > organism

Four fundamental tissue types:
1. Epithelium
2. Connective
3. Muscle
4. Nerve (integrated within other types)

Cell theory, 4 concepts:
1. Basic structural and functional unit of living organisms
2. Activities of an organism depend on the activities of cells
3. Compositions of cells (arrangement of organelles) determine the cell's structure and function
4. All cells come from pre-existing cells

Eukaryotic: has membrane bound nucleus
Prokaryotic: no membrane bound nucleus

Some organelles are membrane bound. This ensure chemical reactions do not interfere, they compartmentalize chemical reactions.

Functions of a cell

1. Cell metabolism and energy use
2. Synthesis of molecules
3. Communication
4. Reproduction and inheritance

Cell membrane	• Phospholipid bilayer
	  • Phosphate is hydrophilic
	  • Lipid tails are hydrophobic
	• Protein channels move molecules either passively or actively

Cytoplasm	• Fluid surrounding organelles • Also called cytosol
Nucleus	• Membrane bound in eukaryotes • Contains DNA
Nucleolus	• Inside the nucleus • Ribosomal RNA (rRNA) synthesized assembled
Ribosomes	• Allow protein translation

Endoplasmic reticulum (ER)	• Rough: (RER)
	  ○ has ribosomes attached to surface
	  ○ Involved in protein synthesis
	• Smooth: (SER)
	  ○ Assembles lipids and carbs
	  ○ Detoxification of drugs and alcohol
	  ○ Stores calcium
	  ○ Sarcoplasmic reticula is a further specialized ER and will be discussed in Muscle topic

Golgi (pancakes)	• Process and package of proteins from the ER • Exocytosis - product leaves the organelle, often in a vesicle (a transport bubble)
Lysosomes	• Digest particles • Involved in cell defense, they are present in macrophages • Endocytosis of bacteria in a vesicle, this fuses with lysosome and digested
Mitochondria	• Changes glucose to ATP (38 ATP molecules per glucose) • This process is called cellular respiration • Mitochondria has its own DNA • It is theorized that a eukaryotic cell ingested/internalized a prokaryotic cell (the mitochondria) and they now have a symbiotic relation

Cytoskeleton	• Holds other organelles in place
	• Consists of 3 things:
	  • Microtubules: extend from centrioles, for intercellular transport
	  • Intermediate filaments: maintains cell shape
	  • Microfilaments: increases SA of cell

Skeletal System

Wednesday, 11 March 2015
10:15 am

DIAPHYSIS -
elongated body of long bone.
EPIPHYSIS -
proximal and distal expanded ends of long bone.
ARICULAR SURFACES -
where bones form joints.
FACET -
smooth, nearly flat, articular surface.
CONDYLE -
rounded articular projection.
SYMPHYSIS -
joint between bones formed by fibrocartilage.
PROCESS -
large, distinct bony projection.
SPINE -
slender, often pointed, bony projection.
FOSSA -
shallow depression.
FORAMEN -
opening in bone, a hole.
MEATUS -
canal-like passageway.
SINUS -
cavity within a bone, filled with air.

- describe the anatomy and structure of bone
- name the bones of the axial and appendicular skeletons and state their functions
- list the main parts of the skull and state their functions
- describe and label the structure of a typical vertebra
- describe at least one unique characteristic of vertebrae in each region of the vertebral column and describe the structure and function of the atlas and axis.

From estrogenic stem cells

Osteoclasts BREAKDOWN	Resorb bone The process is called resorption
Osteoblasts BUILD	Refill resorbed cavities with new bone matrix The process is called ossification
Osteocytes MAINTAIN	Receive nutrients and eliminate wastes • When an osteoblast becomes trapped in the bone matrix, it becomes an osteocyte

25% organic, collagen
50% inorganic, calcium and phosphate
25% water

New bone starts out as cartilage. As the cartilage multiply and mature, older cartilage mineralize. Blood vessels grow into the older cartilage and bring with it osteoblasts.

Axial	Skull, vertebral column (spine), ribs
Appendicular	Arms and legs

Neck	**Cervical**
Chest	**Thoracic**
Abdominal	**Lumbar**
Hip	**Sacral**
Tail	**Coccygeal**

Pelvic girdle		**Coxa**
Lower limb	Thigh	**Femur**
	Knee	**Patella**
	Lower leg	**Tibia**
		Fibula
	Ankle	**Tarsals**
	Foot	**Metatarsals**
	Toes	**Phalanges**

Skeletal System Lect

Thursday, 12 March 2015
2:06 pm

206 bones in the human body
Categorized by shape

- Long
- Short
- Flat
- Irregular

LONG BONE

- Epiphyses, proximal and distal (by distance from trunk of body)
- Shaft OR diaphysis

Compact bone	Strength and rigidity Find it on the epiphyses and the shaft They are made up of harversian systems • Each concentric circle is a lamellae • Lacunae house the osteocytes
Harversian system	Transfer of nutrients by plasma membrane of the osteocytes Canaliculi allow this to occur
Periosteum and endosteum	Periosteum lines the outer bone Endosteum lines the inner bone

Spongy bone	Provide shock absorption Largely located in epiphyses Sandwiched between compact bone
Trabeculae	No central canal Endosteum wraps around it
In the spaces there is bone marrow	RED: red, white BC, and blood elements This was localised at the epiphyses YELLOW: fat cells

Bone formation - ossification

Intramembranous ossification - flat bones only

- Membrane laid down, used as a template
- Stem cells attach to membrane and multiply

Endochondral

- Cartilage is laid down, used as template
- Periosteum is added around the shaft with the osteogenic stem cells
- Blood vessels infiltrate the bone

Epiphyses and the epiphyseal line

- Differentiate into blasts then cytes
- Bone growth occurs here, lengthens bone
- Stops growing at the end of puberty

LOW BLOOD CALCIUM

- Stimulate PTH (parathyroid gland, parathyroid hormone)
    - Stimulate osteoclasts
    - Stimulates kidneys to reabsorb Ca
    - Stimulate vitamin d production by kidneys

HIGH BLOOD CALCIUM

- Stimulates calcitonin by thyroid gland
    - Inhibit osteoclast activity

Increase PTH, increase calcium
Increase calcitonin, decrease blood calcium

PARTS YOU NEED TO KNOW

Axial skeleton (3)

- Skull (4)
- Vertebral column (5)
- Ribs and sternum

Appendicular skeleton (4)

- Pectoral girdle
- Pelvic girdle
- Upper limb
- Lower limb

Fibrous joints (fixed)

- E.g. skull

Cartilaginous joints (slight movement)

- Ribs and sternum
- Between vertebra

Synovial joints (free moving)

- Arms, fingers, legs, wrists
- Filled with synovial fluid

For axial: joints of the ribs and vertebral column (cartilaginous) as well as the skull (fibrous) -- they don't allow much movement, hence more rigid and able to protect vital organs

For appendicular: joints of the arms and legs (synovial) allow for maximum movement -- their function movement