Things to know and study for Exam 1

Lecture 1 - Chapters 1 and 2

<u>What is Science? What is not Science?</u>

-Science is a way of knowing about the natural world--- an epistemology , a way of knowing

-Science and scientist should be objective

-Scientific conclusion may change or be modified as our understanding grows and technology changes

-Science is studied using scientific methods

<u>What is the scientific method and how is it used?</u>

Testable, falsifiable

Results can be reproduced or replicated independently

Often is a **null hypothesis** (H_0**)** and this may be rejected, which supports the alternative hypothesis (H_a) •Results or data can be scrutinized for error and statistical significance

–The observed results are beyond the expectations of the null hypothesis

•Models, hypotheses and theories are only rejected or supported. They are *<u>never</u>* proven!

•Good models hold up to repeated testing

•Absence of evidence is *<u>not</u>* evidence of absence

- **Step 1.** Observe and generalize
- **Step 2.** formulate a hypothesis
- **Step 3.** make a testable prediction
- **Step 4.** experiment or observe
- **Step 5.** modify hypothesis as a necessary and repeat steps 3 and 4, direction of increasing confidence in hypothesis

•Koch's postulates – formulated c. 1890

1. The organism must be shown to be invariably present in characteristic form and arrangement in the diseased tissue.
2. The organism, which from its relationship to the diseased tissue appears to be responsible for the disease, must be isolated and grown in pure culture.
3. The pure culture must (should) be shown to induce the disease experimentally.
4. The organism should be re-isolated from the

experimentally infected subject

•Observations: many patients had a particular bacterium near their ulcers, a lesion produced by gut inflammation

•Hypothesis: *Helicobacter pylori* is the cause of gastritis and ulcers.

• Experiment/observations:

1st – *H. pylori* was isolated and grown from patients with ulcers

2nd – humans swallowing a *H. pylori* solution resulted in inflammation in their stomachs (gastritis)

•Conclusion: *H. pylori* was the cause of many ulcers and can be cured by application of antibiotics

What is a control or a controlled study?

•Variables:

•Experimental variable is the variable that is purposely changed or manipulated

•aka Independent variable

•All other variables need to remain constant or unchanged

•The parameter that responds or changes is known as the dependent variable

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•Groups:

•Test/experimental group is a group of subjects that are exposed to the experimental variable

•Control group is a group for comparison that is not exposed to the experimental variable

•There are many variations on controls

•No properly done experiment lacks controls

What is scientific error? **

Experimental error is the difference between a measurement and the true value or between two measured values. Experimental error, itself, is measured by its accuracy and precision.

What is scientific bias? ***

Scientific bias is the assumption that a theory is true or false without evidence one way or another, or the attempt to dismiss or discourage research efforts to confirm or deny the theory - often on political or ideological grounds. This is generally seen as an obstacle to applying the scientific method

What are Koch's postulates?

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What the characteristics of living things?

All living things reproduce in one of the following ways: Asexual reproduction - Producing offspring without the use of gametes. Sexual reproduction - Producing offspring by the joining of sex cells.

1.Organized from the atom to the biosphere

2.Maintain a relatively constant internal environment (homeostasis)

3.Respond to internal and external stimuli

4.Use materials and energy from the environment

5.Reproduce offspring

6.Growth and development

7.Evolutionary history through which organisms change over time

What is the overriding biological goal?

EVOLUTION

Because we study these challenges and the different solutions (adaptations) adopted over time, we are examining biological variation and selection from generation to generation.

How is matter organized? What levels are involved?

•Atoms
•Molecules
•Macromolecules
•Organelles
•Cells
•Tissues and organs (multicellular organisms)
•Populations
•Communities
•Ecosystems
•Biome/Biosphere

Molecule
The chemical compounds of cells

Cell
The smallest unit of life

Tissue
A group of similar cells that perform the same function

Organ
A structure with two or more tissues working together to perform a function

Organ systems
At least two organs working together to perform a function

Individual
A single organism

Population
All individuals of the same species in an area

Community
All the species in an ecosystem that can interact

Ecosystem
A community and its physical environment

Biosphere
The part of the earth that supports life

What is equilibrium? What is entropy? And how do these relate to the 2nd law of thermodynamics?

- **Equilibrium is equal forces are all balanced out**
- **Entropy is the degree of disorder**

states that the total entropy of an isolated system always increases over time, or remains constant in ideal cases where the system is in a steady state or undergoing a reversible process

These relate to the 2nd law of thermodynamics because the two involves the balancing of forces and the degree of disorder. They are focussed on the systems state of behaviour

What are emergent properties and why are they important?

-Biological organization is built upon a hierarchy of structures

-Each level of chemical and biological organization has emergent properties, *i.e.* novel properties that cannot be predicted from the properties of the constituent parts

- "the whole is greater than the composition of its parts."

-It's the property where living things become more and more complex as it goes from cellular level (exp humans are made of cells) to organ system (exp humans are made of organ system composed of millions of cells).

IT is important because they are the building blocks of complex structures to help perform their functions.

Be able to describe the different bonds between atoms

Hydrogen bond

- Hydrogen bonds occur between a hydrogen atom in a covalent bond and a negatively charged atom (partial charges d) in another molecule

-There is polarity to the charges, *i.e.* water is a polar molecule

-These are relatively weak bonds

Covalent bond

-Atoms in this type of bond *share* electrons

-Results in a stable outer shell

-Relatively strong bonds (need energy to make)

-Most common among biological molecules

Ionic bond

-Atoms in this type of bond *donate* or *receive* electrons

-Results in a stable outer shell of electrons

-Creates particles that are charged (ions)

<u>What is a molecule? What is a macromolecule? What is an ion?</u>

Molecules - are made of atoms that are bonded together and they can be made of the same atom or different atoms
Macromolecules - are very large molecule, such as protein, commonly created by polymerization of smaller subunits (monomers). They are typically composed of thousands of atoms or more.
Ion - an atom or a molecule in which the total number of electrons is not equal to the total number of protons, giving the atom or molecule a net positive or negative electrical charge

Lecture 2 – Chapter 2
<u>Be able to recognize and distinguish characteristics and uses of different macromolecules</u>

Carbohydrates

- **Monosaccharides - glucose / fructose .**
- **Disaccharides - Sucrose , maltose**
- **Polysaccharides - glycogen found in animals, starch found in plants**

ENERGY STORAGE to provide body with energy

<u>Lipids</u> - glycerol molecule and 3 fatty acids = triglyceride

- **Fats**
- **Oil**
- **Phospholipids - Glycerol and 2 fatty acids hydrophilic head, hydrophobic tail**
- **Steroids - cholesterol, estrogen and testosterone**

Do not dissolve in water
Used to make cell membranes
Used as energy molecules
Great insulators

Proteins
Subunits are amino acids .
Polymerized into polypeptide chains
Important for diverse functions in body includes. hormones enzymes transport

AMINO ACIDS LOOK LIKE??
Made up of a amino group, hydrogen atom, side R chain, carboxyl group , central atom

Nucleic Acids

Subunits are nucleotides. Includes DNA and RNA
Functions as Genetic info systems
Nucleotides contain
Phosphate group, 5 carbon sugar, nitrogenous base

Adenine, Guanine are double ringed purines
Cytosine, Thymine and uracil are single ringed pyrimidine

•In DNA, A pairs with T and G pairs with C

•In RNA, A pairs with U and G pairs with C

How is protein structure organized?

They are organized into 4 main components
Primary structure
Secondary structure
Tertiary structure
Quaternary structure

What is ATP and what is its role in cells?
Energy currency for life
High energy molecule found every cells
Its job is to store and supply the cell with needed energy.

Lecture 3 (including supplement) – Chapter 3 and parts of Chapter 21
Why are enzymes important for life and how do they work?

Enzymes increase the rate of chemical reactions without being used up
They are proteins folded into complex shapes that allow smaller molecules to fit into them. The place where these substrate molecules fit is called the active site.

What is cellular respiration?
is a set of metabolic reactions and processes that take place in the cells of organisms to convert biochemical energy from nutrients into adenosine triphosphate (ATP), and then release waste products. DONE BY –Glycolysis

–Citric acid cycle

–Electron transport chain

What are cells composed of?

Cell organelles and elements of CHONPS
Carbon hydrogen oxygen nitrogen phosphorus sulfur

What are the 3 domains of living organisms on earth?
Archaea bacteria eukaryote

What is a cell membrane and what functions does it provide?

Lets materials in and out of the cell, protects the internal environment of the whole cell

Be able to describe tonicity, diffusion, and osmosis.

Tonicity - is the measure of osmotic pressure of the cell generally of water in a selective membrane
Isotonic - no net movement of water
Hypertonic - more water out cell, shrinking

Hypotonic - more water in cell, bloated , expands and may explode

Diffusion - the movement of molecules in a selective membrane from high [ ] to low [ ] gradient
Osmosis - the movement of water from low [ ] to high [ ]

Be able to distinguish types of transport.

Active transport - requires energy, moves against [ ] gradient from low to high
-endocytosis/exocytosis/receptor-mediated endocytosis

Passive transport - does not require energy, moves with [ ] gradient from high to low
diffusion/osmosis/facilitated diffusion

What are prokaryotic and eukaryotic cells? Know their differences.
Prokaryotic cells - simplest living things, no nucleus, they are bacteria and archaea, simple cells , unicellular
Eukaryotic cells - Us humans, living organisms,Have nucleus, multicellular

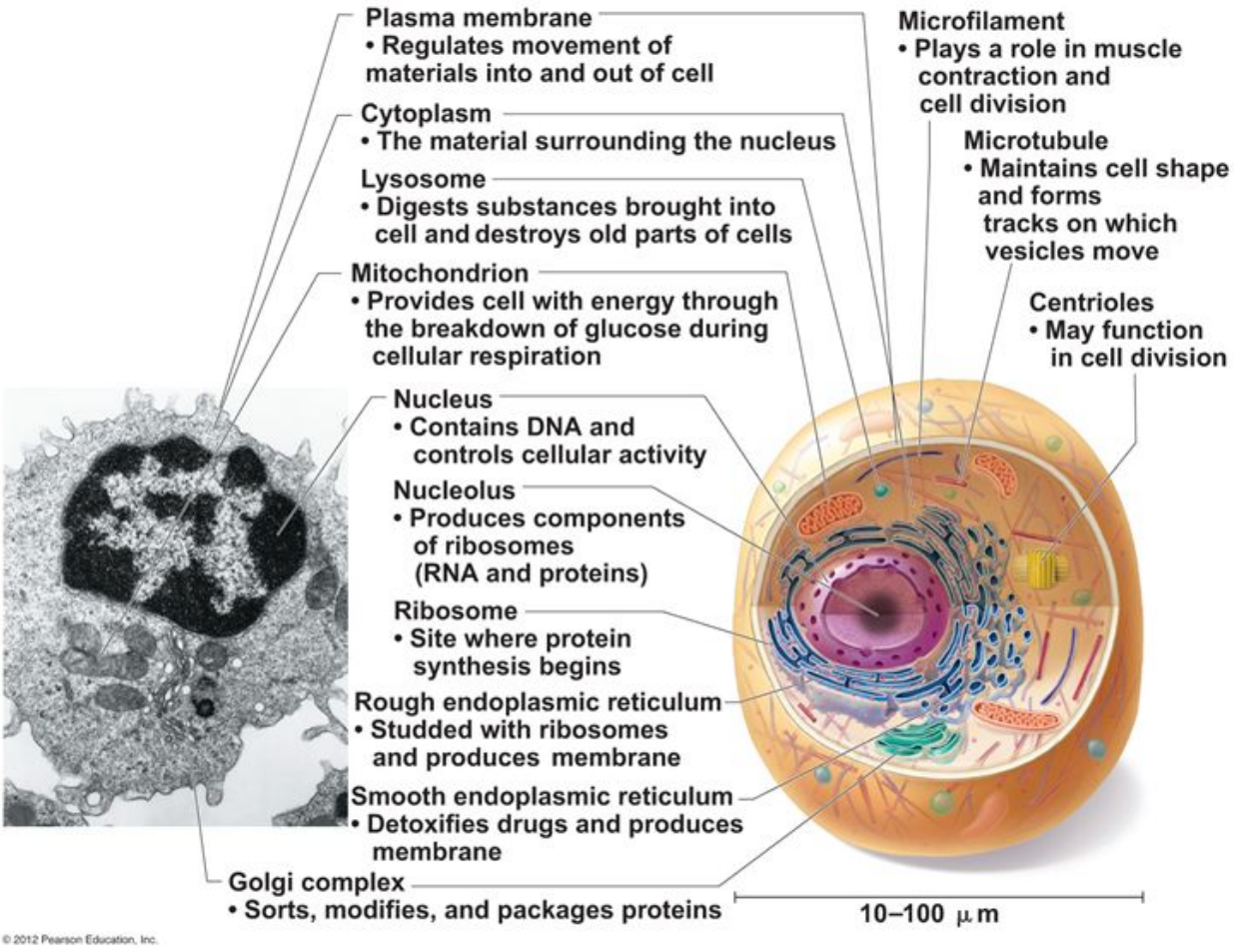
How did eukaryotic cells originate?
Endosymbiotic Theory of Evolution of Eukaryotic Cells. THE THEORY: The mitochondria and chloroplasts of Eukaryotic cells arose from the symbiotic incorporation of prokaryotic cells by a proto-eukaryotic cell. ... Eukaryotic cells originated more than 0.6 billion years ago

What are the major roles of the different organelles?
Mitochondria- produces energy through cellular respiration
rough endoplasmic reticulum- transport and storage
Ribosomes- create proteins
smooth endoplasmic reticulum- creates lipids or fat

Chloroplast creates glucose
golgi apparatus- synthesis, packages and releases concentrate proteins or lipids
golgi body- protein or lipid enters the cytoplasm
Cytoplasm- where all chemicals take place

Peroxisome -microbodies found in animal cells
Glyoxysome- microbodies found in plant cells
Centrioles- for cellular division and cellular reproduction
Cytoskeleton -supports structure and helps move synthesized proteins
Lysosomes- contain hydrolytic enzymes for digestion
contractile vacuole- pump water out of cell
Vesicle -moves protein, lipid and carbohydrate
nuclear envelope- surrounds the nucleus
Vacuole -contains food or water
cell membrane- separates cell contents from the environment
Microtubules- provide internal support
Nucleus- information center of the cell
Nucleolus- site of ribosome synthesis
Chromatin- threadlike mass of DNA

Cardiac - tissues at the heart



Be able to locate parts of cells and name them.

What do the cytoskeletal elements do for the cell?

Eukaryotic cells contain three main kinds of cytoskeletal filaments: microfilaments, microtubules, and intermediate filaments. ... The microtubules are made up of the protein called tubulin which has a diameter of 25 nm. Intermediate filaments are made up of various proteins which varies depending on the cell type

What is the endomembrane system?

These membranes divide the cell into functional and structural compartments, or organelles. In eukaryotes the organelles of the endomembrane system include: the nuclear membrane, the endoplasmic reticulum, the Golgi apparatus, lysosomes, vesicles, endosomes and the cell membrane.

What is endo/exocytosis?

Active transport, endo is transporting material in cell, exocytosis is transporting materials outside cell, both requires ATP.
Endo uses phagocytosis and pinocytosis
Exo uses a sac or vesicle

What is the structure of DNA and a chromosome?

Chromosomes are packaged by histone proteins into a condensed structure called chromatin. The first level of packaging is represented as the “beads-on-a-string” structure. The condensed chromatin is folded and tightly coiled, like a coiled telephone cord, allowing the cell's DNA to be packed into the nucleus.

What is the central dogma of molecular biology?

"the coded genetic information hard-wired into DNA is transcribed into individual transportable cassettes, composed of messenger RNA (mRNA); each mRNA cassette contains the program for synthesis of a particular protein (or small number of proteins)."

What is a gene?

is the basic physical and functional unit of heredity. Genes, which are made up of DNA, act as instructions to make molecules called proteins

How is gene expression regulated and why?

What is transcription?

in which a particular segment of DNA is copied into RNA (mRNA) by the enzyme RNA polymerase. Both DNA and RNA are nucleic acids, which use base pairs of nucleotides as a complementary language.

What is translation?

is the process in which cellular ribosomes create proteins
messenger RNA (mRNA)—produced by transcription from DNA—is decoded by a ribosome to produce a specific amino acid chain, or polypeptide.

What is the genetic code?

is the set of rules by which information encoded in genetic material (DNA or RNA sequences) is translated into proteins (amino acid sequences) by living cells.

Lecture 4 – Chapter 19

How do cells grow and divide?

Once it has copied all its DNA, a cell normally divides into two new cells. This process is called mitosis. Each new cell gets a complete copy of all the DNA, bundled up as 46 chromosomes. Cells that are making egg or sperm cells must divide in a different way.

What is ploidy?

the number of sets of chromosomes in a cell, or in the cells of an organism.

Be able to describe the order of the cell cycle and the function of each phase.

Interphase
Prophase
Metaphase
Anaphase
Telophase
cytokinesis

What are chromosomes and the essential parts of a human chromosome?

is a packaged and organized structure containing most of the DNA of a living

Sister Chromatids - these are two identical copies of the chromosome. During cell division all the DNA of each chromosome is replicated. They eventually separate to become a full chromosome.

Centromere - the central region of the chromosomal structure. It's where the two sister chromatids are joined to each other.

DNA - dubbed the molecule of life. Each chromosome contains a long linear molecule of DNA and there's more than two metres of it in each one. So for it to be able to fit it's tightly wound around histone proteins.

Telomeres - repetitive DNA sequences that are situated at the tips of chromosomes (the repeated sequence reads - TTAGGG). They are vital to the survival and life of the chromosome.

What is the spindle and why is it important?

a spindle-shaped structure, composed of microtubules, that forms near the cell nucleus during mitosis or meiosis and, as it divides, draws the chromosomes to opposite poles of the cell.

Be able to describe the events in each stage of mitosis

interphase- cell is engaged in metabolic activity and performing its prepare for mitosis

prophase- The nucleolus disappears. Centrioles begin moving to opposite ends of the cell and fibers extend from the centromeres.

prometaphase- The nuclear membrane dissolves, marking the beginning of prometaphase. Proteins attach to the centromeres creating the kinetochores.

metaphase- Spindle fibers align the chromosomes along the middle of the cell nucleus so that when the chromosomes are separated, each new nucleus will receive one copy of each chromosome.

anaphase- The paired chromosomes separate at the kinetochores and move to opposite sides of the cell.

telophase- new membranes form around the daughter nuclei and cytokinesis or the partitioning of the cell may also begin during this stage.

cytokinesis- In animal cells, cytokinesis results when a fiber ring around the center of the cell contracts pinching the cell into two daughter cells, each with one nucleus. In plant cells, the rigid wall requires that a cell plate be synthesized between the two daughter cells.

Distinguish meiosis from mitosis

Meiosis has two rounds of genetic separation and cellular division while mitosis only has one of each. In meiosis homologous chromosomes separate leading to daughter cells that are not genetically identical. In mitosis the daughter cells are identical to the parent as well as to each other.

http://www.yourgenome.org/facts/mitosis-versus-meiosis

How does meiosis generate genetic variation?

Crossing Over. During prophase of meiosis I, the double-chromatid homologous pairs of chromosomes cross over with each other and often exchange chromosome segments. This recombination creates genetic diversity by allowing genes from each parent to intermix, resulting in chromosomes with a different genetic complement.

Be able to describe the overall reproductive cycle in humans

Lecture 5 – Chapter 4 and parts of Chapters 19a and 21a

What is a tissue? Organ? Organ system?

The body's functions are conducted by organs. Each organ is a recognizable structure (for example, the heart, lungs, liver, eyes, and stomach) that performs specific functions. An organ is made of several types of tissue and therefore several types of cells (see Cells).

How do cells interact and communicate with one another?

Gap junctions. Gap junctions are the main site of cell-cell signaling or communication that allow small molecules to diffuse between adjacent cells. ... Each pore is made of 12 connexin molecules; 6 form a hemichannel on one cell membrane and interact with a hemichannel on an adjacent cell membrane.

What are the 4 main types of tissue?

epithelial, connective, muscular, and nervous tissue

What is the integumentary system and its main roles?

The integumentary system consists of the skin, hair, nails, glands, and nerves. Its main function is to act as a barrier to protect the body from the outside world. It alsofunctions to retain body fluids, protect against disease, eliminate waste products, and regulate body temperature.

How is epithelial tissue organized?

Epithelial tissue covers the body, lines all cavities, and composes the glands. Epithelial tissue is composed of cells laid together in sheets with the cells tightly connected to one another. Epithelial layers are avascular, but innervated.

Epithelial cells have two surfaces that differ in both structure and function.

Glands, such as exocrine and endocrine, are composed of epithelial tissue and classified based on how their secretions are released.

What is homeostasis and how is it maintained?

Homeostasis is a characteristic of a system that regulates its internal environment and tends to maintain a stable, relatively constant condition of properties.
The nervous and endocrine systems exert the ultimate control over homeostasis because they coordinate the functions of the body's systems. Regulation of body temperature, blood pressure, pH, and glucose concentration are four examples of how the body maintains homeostasis.

How do negative and positive feedback work in homeostatic regulation?

What are stem cells? What is a niche?

an undifferentiated cell of a multicellular organism that is capable of giving rise to indefinitely more cells of the same type, and from which certain other kinds of cell arise by differentiation

What is differentiation, dedifferentiation, transdifferentiation?

What is cloning and what may it be used for?

For research and therapeutic purposes

What are the characteristics of cancer cells?

1.Appear dedifferentiated (though they often retain some characteristics of tissue origin) and do not contribute to body functioning

2.Have abnormal nuclei that are enlarged and may have an abnormal number of chromosomes (aneuploidy)

3.Arise from dividing (mitotic) cells and have unlimited ability to divide

4.Can typically divide without growth factors

5.Form tumors

6.Migrate and invade new tissues

7.Undergo metastasis and angiogenesis

8.Become abnormal gradually through a multistage process

What is meant by the multistage/multistep/multihit model for the development of cancer?

Why does cancer take time to develop?

What are some hallmark stages of tumor progression?

(1) Cancer cells stimulate their own growth (Self-sufficiency in growth signals); (2) They resist inhibitory signals that might otherwise stop their growth (Insensitivity to anti-growth signals); (3) They resist their programmed cell death (Evading apoptosis); (4) They can multiply indefinitely (Limitless replicative potential) (5) They stimulate the growth of blood vessels to supply nutrients to tumors (Sustained angiogenesis); (6) They invade local tissue and spread to distant sites (Tissue invasion and metastasis).

What is a mutagen? What is a carcinogen?

Mutagen is

a change in the nitrogenous-base sequence of DNA; that change causes a change in the product coded for by the mutated gene

a substance capable of causing cancer in living tissue.

Why are carcinomas the most prevalent type of cancer?

Carcinoma occurs in the epithilial tissues, they line the gut prostates, breast, lungs and other glands. And these cells are constantly replicating, therefore it has higher risk of developing cancer cells

What are some warning signs of possible cancer?

•Change in bowel or bladder habits

•A sore that does not heal

•Unusual bleeding or discharge

•Thickening or lump in breast or elsewhere

•Indigestion or difficulty in swallowing

•Obvious change in wart or mole

•Nagging cough or hoarseness

What are some common screens for cancer and why are they important?

•Self-examination – monthly exams of breasts and testicles starting at age 20

•Colonoscopy – every 5 years starting at age 50

•Mammogram – yearly after age 40-45

•Pap smear – recommend these 3 years after vaginal intercourse or no later than age 21

•Prostate exam – should begin at age 50 if family history of cancer

What are the methods for treating cancer?

•Surgery to remove small, localized tumors

•Kill the more rapidly dividing cells which are found in tumors

•Chemotherapy

•Radiation therapy

–Naturally, this method has some inherent toxicity to normal dividing cells

•Immunotherapy

–inject immune cells that are genetically engineered to display or seek out the tumor's antigens

–antibodies that are linked to radioactive isotopes or chemotherapeutic drugs are injected into the body to find and kill cancer cells

•Angiogenesis inhibition

–angiostatin and endostatin are drugs in clinical trials that appear to inhibit angiogenesis and this starves a tumor of oxygen

•Others therapies aimed at limiting cues that promote cell growth

–tamoxifen & raloxifene: estrogen antagonists used in breast cancer therapy

•Need to kill cancer cells specifically – not easy!

–Need for specific information on the unique features of the cancer cells vs. normal cells

–Need for specific targeting of drug to the cancer cell vs. normal cell

–There are only a handful of these – e.g. Gleevec

Lecture 6 – Chapters 5 and 6

What are the main functions of the skeletal system?

What are the parts of a long bone?

What are the different cell types in bones and what do they do?

How do bones grow, remodel and repair?

How are hormones involved in bone growth?

What is osteoporosis? What is arthritis?

What are the functions of the muscular system and the 3 types of muscles?

How are skeletal muscles and muscle fibers organized?

What are the parts of muscle cells and the sarcomere?

How do skeletal muscles contract? How do skeletal muscles relax?

What are the sources of fuel or ATP for muscles and how does it relate to fast or slow twitch fibers?

What are some common muscular disorders and diseases?

How do the skeletal and muscular system help maintain homeostasis?