THE FOLLOWING RESOURCE MAY NOT COVER ALL FINAL EXAM MATERIAL

SCB 201 Lecture quiz and test master review sheet.

This review sheet only serves as a GUIDE for your studying. You should also consult your book and notes. This document includes all review sheets distributed in Keller SCB 201 lecture in 2023 plus sample questions at the end. Some of the later topics are less itemized. Example questions are included at the end of the document (note that the example questions at the end of this document are from the second half of the class)

You should know the following things:

Basic attributes of life as discussed in class

What cell theory is, what it says, how it contrasts with spontaneous generation, and Pastuer's classic experiment that we discussed in class.

Evolution by natural selection including Darwin's basic ideas to the extent that we discussed them in lecture (there must be variability within a population, that variability must be heritable, etc.…). We talked briefly about taxonomy and the tree of life. I won't ask about the specifics of all the different classification schemes but you should know genus/species and generally what taxonomy is. What is the relationship between evolution and taxonomy? You should be able to identify natural selection and artificial selection if presented with examples.

Be able to identify, explain, and apply the elements of the scientific method (hypothesis, theory,experiment, etc…). I won't ask about details that were only discussed in lab.

Intro to Chemistry/organic chemistry.

You should know the parts of an atom and their properties to the extent we discussed them (mass, charge, etc.). Know what atomic number, and atomic mass mean (if I give you an atomic number for some atom, you should be able to tell me several things about that atom including how many electrons it has, how many bonds it will form, etc.).

Kinetic and potential energy. Which electrons have more potential energy?

Know how many electrons each electron shell can hold and what is meant by "valence" electrons.

Isotopes… know what they are and why they are useful.

Understand how atoms are put together and why. Remember, atoms "desire" to have full valence shells and this is largely why they combine with other atoms.

Covalent bonds

Polar and non-polar. This requires you to understand electronegativity!! So… understand electronegativity

Ionic bonds (know what ions are and how they bond with each other)

Hydrogen bonds… again, this requires you to understand electronegativity

Understand why water is special and what its special properties are (we discussed several)

Understand the basics of PH (more hydrogen ions means lower PH, acidic vs. basic, etc.). I won't ask you to know the math.

What is a buffer?

Understand the basics of chemical reactions as we discussed in class including

Potential energy of electrons, what products/reactants are, what factors make a reaction more likely to happen or proceed once begun (temperature, concentration, potential energy of products/reactants, and degree of order).

Functional groups (I won't ask you to draw or identify any functional groups but you should know in general what they are and why they are important). Don't worry about memorizing these but be able to guess what the result of adding some functional group to a molecule might be… would it be more or less polar? Would it be soluble in water? That kind of thing.

Macromolecules

Know the four classes of macromolecules and their general characteristics/functions.

How are monomers added to polymers (what kind of reaction) and how are they removed? You should understand the general concept of polymerization.

For each of the categories of molecules we discussed, you should know what they do, what they are made of (what are the monomers? What are the basic building blocks?), and what are their properties (solubility, polar vs. non polar etc). You should understand how the monomers are put together to make larger things. You should know the difference between DNA and RNA, what the parts of nucleotides are, what the parts of a phospholipid are including saturated vs. unsaturated fats. How do triglycerides differ from phospholipids? Why are lipids hydrophilic on one end of the molecule and hydrophobic on the other end? What proteins are made of, what side groups are, types of carbohydrates we discussed (mono, di, poly, hexose, pentose), how complementary base pairing works, You should understand directionality of nucleic acid molecules. levels of protein structural complexity and what each level is based on. Understand what denaturation is and what causes it (we discussed this in the context of enzymes). I won't ask you to draw or identify specific molecules though you should be able to differentiate the various types of macromolecules from each other if presented

with an example. I won't ask you to know specific amino acids though you should know how they differ from each other in general.

Enzymes

Understand what enzymes are, what their properties are to the extent that we discussed them in class, and why they are important. Understand the naming conventions we discussed (you don't need to memorize the examples). Understand the lock and key model of enzymatic function Why do we use that analogy? How are enzymes regulated? What is meant by "induced fit?" What factors influence their activity?

Origin of organic molecules:

How old Earth is and roughly when the first evidence of life is observed. How do we know?

Where on Earth do we think life started and why?

You should know what the Miller Urey experiment showed and why it is important.

You should be able to speculate as to the origin of the various molecules needed for life to the extent that we discussed in class. Where did they come from? How were they formed?

You should know what the RNA world hypothesis is.

DO NOT: Memorize the periodic table, worry about elements other than the ones we talked about, memorize years, memorize isotope half-lives, memorize the blood buffer chemical equation, memorize the PH of various substances like soda. Don't worry about memorizing specific molecular structures but you should be able to recognize a hexose or a pentose, a phospholipid, an amino acid or a purine/pyrimidine were you to see one. Don't memorize specific examples but understand the concept they illustrate. Good luck!

Example multiple choice

9. Differences among amino acids are determined by
   A. The amino group
   B. The Carboxyl group
   C. The phosphate group
   D. The R group

Which of the following is NOT a property of water?:

A. Polarity

B. Hydrogen bonding
C. It makes a good solvent for non-polar substances
D. High heat capacity.

BIOLOGICAL MEMBRANES

What are biological membranes made of? What about phospholipids makes them good for forming barriers? Understand the structure of P-lipids enough to understand their behavior.

Permeability (know what can and cannot get through lipid bilayers and why). Know what factors influence permeability.

Understand the role of the proteins that are found in cell membranes (we talked about several different roles and there is a slide summarizing those roles) I won't ask about the different mechanisms of ion channel gating. What is the fluid mosaic model and what does it mean?

Understand the different types of cell transport that we discussed (know which ones require energy and which ones do not, which ones work against concentration gradients and which ones do not, simple diffusion, osmosis, facilitated diffusion, active transport, Endocytosis [includes phagocytosis, pinocytosis, and receptor-mediated endocytosis]), exocytosis.

CELL STRUCTURE AND FUNCTION

Know the difference between prokaryotes and eukaryotes (we mentioned several things: Size, presence of compartments, arrangement of DNA etc… How are prokaryotic and Eukaryotic cells similar? What do they share and what don't they share?

Plant vs. Animal cells (basically these differences are the cell wall, centrioles, chloroplasts, lysomes and vacuoles).

You should know the organelles we discussed and basically what they do. Note that a few of these are not membrane bound like ribosomes, the cytoskeleton, and centrioles

Nucleus

Command center, contains the DNA, entry and exit regulated by nuclear pores (nuclear localization signal lets things get in), nucleolus (where ribosomal components are assembled), nucleolus, chromatin, etc…

Ribosomes (make protein. Found in the cytoplasm and bound to the rough ER)

Endomembrane system: You should know how proteins get processed for secretion in the endomembrane system (glycosylation, etc…). We talked about the secretory pathway.

Rough Endoplasmic Reticulum

Golgi apparatus

Lysosomes

Smooth ER

No ribosomes. Involved in lipid processing

Mitochondria

Make most of the cell's ATP. Have their own DNA (suggests endosymbiotic origin). Double membrane

Peroxisomes

Break down fatty acids and amino acids. Detoxify hydrogen peroxide by the activity of the enzyme Catalase

Centrioles (located in centrosome)

Assemble microtubules during cell division in animals

Cytoskeleton

Three general types of filaments made of protein (microfilaments, intermediate filaments, Microtubules)

Provide cellular structure

Allow movement

Know what molecular motors do

Act as molecular "highways"

Pull chromosomes apart during cell division

Chloroplasts

Site of photosynthesis in plants. Contain their own DNA suggesting endosymbiotic origin. Double membrane

Cellular Respiration

You should know the three main stages of respiration including where they occur, what the inputs and outputs are (what goes in and what comes out of each stage), how many ATP and reduced electron carriers are produced in each stage, and whether or not oxygen is needed and WHY.

What are redox reactions and where are they important during cellular respiration

What are electron carriers and why are they important?

What is ATP and why is it a good energy molecule?

You should know which mechanism of ATP production is used in each stage of cellular respiration (we discussed two mechanisms).

I don't expect you to know all of the specific molecules found in Glycolysis or in the Kreb's cycle but you should understand the two key regulatory enzymes that we discussed and how THEY are regulated.

You should understand what happens to Pyruvate before it enters the Kreb's cycle. What is done to it? What role does acetyl Co-A play? What are the products of the intermediate step and how is it regulated?

You should understand the electron transport chain. What is it? Where do the electrons come from? Where do they go? Where is the electron transport chain found? What is done with the energy that the electrons lose?

Where do we see a proton/hydrogen ion concentration gradient established? Why is it important? What do we do with it?

What is ATP synthase? Why is it important? What does it do? Where is it found?

You should understand the two types of fermentation we discussed including when/where they would occur and why they would occur.

I won't ask the details about where the other macromolecules can be fed into the process of cellular respiration but you should understand that other molecules can be used as substrates for cellular respiration, not just glucose. You should also understand that molecules produced during cellular respiration can be removed from the process and used to build other things the cell needs such as nucleotides.

Photosynthesis

You should understand autotrophs vs. heterotrophs

You should understand the basics of leaf anatomy to the extent that we discussed it. What are the parts and what function do they serve?

You should understand the basics of chloroplast structure. Including where the photosynthetic reactions take place and where chlorophyll can be found.

You should understand the distinction between the light dependent and dark reactions/Calvin cycle.

We discussed the nature of light a little bit. I don't expect you to understand all the physics of light or wavelength numbers but you should understand that visible light is part of the electromagnetic spectrum, what photons are, the relationship between wavelength and energy (in general), and what happens when light hits a surface (it's either absorbed, transmitted, reflected, or diffracted). Why are plants green?

You should understand what photosynthetic pigments are and why they are special. What role do they play in photosynthesis? What is the main photosynthetic pigment? What do accessory photosynthetic pigments do? I won't expect you to remember wavelength numbers.

You should understand non-cyclic electron flow during the light-dependent reactions. This requires you to understand how electrons are excited by light and how that energy is "bounced" around, what reaction centers are, how electrons are transferred to electron transport chains, what is produced by those electron transport chains, how photosystems one and two relate to each other, and how the electrons that are sent into electron transport chains are replaced. I will NOT expect you to know the specific components of the electron transport chains or the specific names of molecules found in the reaction centers.

We briefly discussed C3 vs. C4 vs. CAM photosynthesis. I won't ask the details but you should understand why C4 and CAM adaptations are beneficial in hot, sunny, humid climates (C4 we separate carbon fixation in space to overcome photorespiration) and in hot dry climates (CAM we separate carbon step fixation in time to avoid excess dehydration and photorespiration)

Mitosis/meiosis

You should understand the differences between mitosis/meiosis and what each process of cell division is used for.

You should know the four phases of mitosis, the phases of the cell cycle and what is happening during each phase (remember that mitosis is part of the overall cell cycle. Interphase makes up the rest of the cell cycle and has three parts)

How is the cell cycle regulated? What did the cell fusion experiments we discussed show in this regard? What is MPF and how does it work? What is the relationship between cyclin and cyclin-dependent kinase? What are cell-cycle checkpoints? What is apoptosis and why is it important? What is P53 and why is it important? What is cancer?

You should know the stages of meiosis and what is happening during those stages.

Know the terminology that we introduced including but not limited to chromatid, centromere, tetrad, kinetochore, homologous chromosomes, ploidy, diploid, haploid, tetrad, etc…

Understand how cytokinesis works.

What is the mitotic spindle and what does it do. What role do centrioles play? How do microtubules move chromosomes?

How does meiosis generate genetic diversity?

What is crossing over and how does it work?

What is non-disjunction and what is the result of non-disjunction events?

What is karyotyping and why is it useful?

How is biological sex determined in humans?

Genetics.

You should understand the basic terminology we used (phenotype, genotype, trait, genes, alleles, homozygous, dominant, recessive, heterozygous, etc…)

You should understand the basic findings that Mendel described (each parent contributes equally, etc., alleles don't blend, each parent contributes one, etc)

You should understand what pure breeding lines are and why they are important. What genotype do pure breeding pea plants HAVE to be?

Why are peas good organisms for studying inheritance?

You should be able to perform a simple monohybrid cross using a punnet square to illustrate your work

Why does each individual only carry two alleles for a gene?

You should be able to apply your understanding of chromosomes and meiosis to genetics.

You should understand genotypic and phenotypic ratios

You should be able to use punnet squares to work genetics problems.

I won't expect you to perform dihybrid crosses but you should understand what they are.

You should understand Non-Mendellian inheritance… exceptions to Mendel's simple "one gene with two alleles, Dom/rec" examples. We discussed Linked genes, incomplete dominance, multi-gene traits, sex-linked characteristics, and a few others. You should know what these are and be able to identify examples.

DNA as the molecule of heredity

You should understand the important experiments illustrating that DNA is the molecule of biological information/heredity and the experiments which clarified the structure and composition of DNA. You should understand the work of Griffith, Avery, Chargaff, and Watson/Crick/Franklin to the extent that we discussed them. You should understand what these experiments showed and why they were important. I won't ask about dates. I won't ask about the Messelsohn-Stahl experiment.

DNA replication

You should understand how DNA replication works. A good way to study might be by creating your own labeled drawing including all of the important enzymes involved. You should know when replication happens, what the point is, the difference between what happens on the leading vs. lagging strands, how it works and all of the important enzymes that we discussed in class (including what they do). We mentioned Primase, Topoisomerase, Helicase, DNA polymerase I and III, and Ligase. Note that we used the prokaryotic DNA polymerase terminology. We also discussed the end replication problem and Telomerase. You should understand how DNA actually stores information. What are codons? Why are they three letters long and not two? What are the "letters" in DNA? What happens when DNA synthesis goes wrong? What is a frameshift mutation? What is a point mutation? Why are some mutations "silent?"

Transcription

You should understand how transcription works in Eukaryotes and in prokaryotes. What are the differences? What is the cap and tail for? What is Sigma and what does it do? What are promoters and why are they important? What is a consensus sequence? What is an intron/exon? What is transcribed and what isn't? What does RNA polymerase do and why do Eukaryotes have three? etc..

Translation

You should understand how initiation and termination of translation happens. How does the ribosome recognize the mRNA? How does the correct amino acid get to the ribosome at the correct time? You should understand how tRNAs are loaded with amino acids. You should understand codon/anti-codon base pairing. You should understand how the elongation cycle works. How is translation terminated? What are common types of post-translational processing?

Regulation of gene expression in Prokaryotes

You should know what the Lac operon is and why it is of interest. You should understand the function of the two proteins encoded by the operon (we didn't discuss the third in any detail). You should understand repression and how it is removed. You should understand how the cell enhances transcription of the Lac operon by the activity of CAP (activated by cAMP). You should basically know whether the lac operon is transcribed at low levels, high levels, or not at all under various conditions of glucose/lactose availability and you should know why. You should know how the presence/absence of glucose/lactose influence transcription of the lac operon. How and when does CAP enhance transcription of the lac operon? Drawing might be a good way to study.

Regulation of gene expression in Eukaryotes

You should know how this works to the extent that we discussed in class. Remember, this is similar to how it works in Prokaryotes but we have some additional levels of complexity including chromatin remodeling (histone acetylation/deacetylation), additional types of regulatory sequences (basal promoter, proximal elements, distal elements, etc…), more than one RNA polymerase, alternative splicing, and RNA interference. What are transcription factors and what do they do? Why are some

genes only expressed in certain types of cells and not others? Understand how the activity of regulatory transcription factors can result in cell-specific gene expression. How is TBP similar to Sigma? Etc…

Genetic Engineering

You should understand the basic tools of genetic engineering we discussed including restriction enzymes, plasmids, reverse transcriptase, and ligase. You should understand how we clone DNA into plasmids. You should understand how and why cDNA libraries are made, screened, and how they work. You should understand how PCR works including why a heat-stable polymerase is needed. I won't ask about microarrays (except as extra credit, perhaps). You should understand how PCR can be modified to sequence DNA. You should know what CRSPR is and why it is useful but I won't ask you to explain how it works.

Genomes

We briefly mentioned a few concepts related to genomes. You should know what genomes are and what general trends are observed when genomes from various species/taxa are compared. How do prokaryote and eukaryote genomes compare? What makes up most of our genome? Is there a relationship between how many genes an organism has and how "complex" it is? I won't ask about specific numbers of genes etc…

Development

You should understand the four essential processes of development (cell movement, differentiation, etc…). We discussed development in fruit flies. You should understand the basic logic of how that works and what bicoid and homeotic/ hox genes do in general. What are maternal effect genes? What is bicoid and what does it do? How are more and more specific regions of gene expression established in the embryo?

WE discussed the stages of animal development so you should understand those stages to the extent we discussed them in class (fertilization through organogenesis) including the establishment of the three dermal layers, the notochord, somites, etc… How is polyspermy prevented? How do the sperm and egg recognize each other? Why does the nervous system arise from ectoderm? What does the notochord do? etc…

Evidence for Evolution

You should understand the difference between evolution and special creation. What is meant by a species being "fixed?" We discussed several categories of evidence. You should understand these categories and be able to recognize examples. We discussed the fossil record, artificial selection,several types of homology, vestigial features, and biogeography. You should understand how these categories support the theory of evolution.

Mechanisms of evolution.

You should understand Lamarkian vs. Darwinian evolution. I won't ask about specific dates. You should understand the basic idea of Natural selection as put forth in Darwin's five postulates. You should really understand the idea that evolution is basically changes in allele frequency in populations over time. You should understand evolutionary fitness. You should understand variation, why it is important, where it comes from, why heritability is important, etc. You should understand what makes that happen. You should understand the difference between Natural Selection and Genetic Drift. You should understand the types of genetic drift , the types of Natural selection, and be able to recognize them if presented with examples. You should understand the Hardy Weinberg model CONCEPTUALLY but I won't ask about any complicated math. You should understand the 5 assumptions and why those assumptions are often not true. You should understand sexual selection, the effects of inbreeding etc. How can violation of the HW model's assumptions lead to changes in allele frequency?

You should understand the basics of speciation. How are new species formed? Understand barriers to gene flow including the difference between pre and post zygotic barriers. You should understand speciation in sympatry and allopatry including the types and you should be able to recognize examples. I won't ask about hybridization.

History of life.

You should understand the general history of life on Earth to the extent that we discussed in class but I won't ask about specific dates or names with the exception of the Cambrian explosion (you should know what that was and why it was important). You should understand possible causes of the Cambrian explosion. You should understand in general what mass extinctions and adaptive radiations are and why they are important. You should understand what life was like on Earth Pre-Cambrian vs. post-Cambrian. You should understand the causes of the end-Cretaceous and end-Permian mass extinctions.