AT Biology Midterm Topics 2013-2014

1) Ch. 2 – Inorganic Chemistry
    a. Atomic structure
    b. Isotopes
        i. Isotope applications
    c. Bonds
        i. Ionic Bonds
        ii. Covalent Bonds
            1. Polar covalent
            2. Non-polar covalent
        iii. H Bonds
        iv. Van der waals
2) Ch. 3 – Water
    a. Properties of water due to H bonds
        i. Adhesion
        ii. Cohesion
        iii. High surface tension
        iv. High specific heat
        v. High heat of vaporization
            1. Evaporative cooling
        vi. Ice floats
        vii. Good solvent
    b. pH
3) Ch. 4 – Carbon
    a. Tetravalent
    b. Isomers (structure vs. function)
        i. Structural
        ii. Geometric
        iii. Enantiomers
    c. Functional groups
        i. Hydroxyl
        ii. Carboxyl
        iii. Carbonyl
        iv. Amino
        v. Sulfhydryl
        vi. Phosphate
        vii. Methyl
4) Ch. 5 – Biological Molecules
    a. Monomer vs. Polymer
    b. Dehydration synthesis vs. Hydrolysis
    c. Macromolecules
        i. Carbohydrates
            1. Mono-, di-, polysaccharides. Example of each
            2. Function of carbohydrates
                a. Energy
                b. Structural components
                    i. Cellulose

ii. Chitin
3. Ratio between C, H and O

ii. Lipids
1. Function of lipids
a. Energy
b. Cell membrane component (phospholipid)
c. Some are steroid hormones
2. Triacylglyceride
a. 1 glycerol + 3 fatty acids
3. Saturated vs. Unsaturated fats
4. Cholesterol

iii. Proteins
1. Functions of proteins
a. Enzymatic
b. Structural
c. Storage
d. Transport
e. Hormonal
f. Receptor
g. Contractile/Motor
h. Defensive (antibody)
2. Structure of proteins
a. Monomer = amino acid (know the structure)
b. Polymer = polypeptide
c. Amino acid categories = nonpolar, polar, charged (acidic, or basic)
d. Four levels of protein structure
i. Primary – sequence of amino acids
ii. Secondary – interactions between backbone (H bonds)
1. Alpha helix
2. Beta pleated sheats
iii. Tertiary – interactions between R groups
1. H Bonds
2. Disulfide bonds
3. Hydrophobic interactions
4. Ionic bond
iv. Quaternary – interactions between multiple polypeptides
e. Denaturation
3. Nucleic Acid
a. Function of nucleic acid – carries genetic code
b. Monomer = nucleotide
c. DNA vs. RNA

5) Ch. 6 – Cells
a. Microscopes
i. Light Microscope
ii. Transmission Electron Microscope (TEM) vs. Scanning electron microscope (SEM)
b. Prokaryotic cell vs. Eukaryotic cell
c. Cell membrane structure (Phospholipid bilayer, fluid mosaic model)

d. Why do cells have to be small? SA/Vol ratio
e. Animal vs. Plant cell
f. Organelles and their function
    i. Nucleus and nuclear envelope
    ii. Ribosomes (free vs. bound to RER)
    iii. Endoplasmic reticulum (ER)
        1. Smooth ER
        2. Rough ER
    iv. Golgi apparatus
    v. Lysosome
    vi. Vacuole
    vii. Mitochondria
    viii. Chloroplast
    ix. Peroxisome
    x. Centrioles
g. Endomembrane system
h. Endosymbiotic theory
i. Cytoskeleton
    i. Three components
        1. Microtubules
        2. Microfilaments
        3. Intermediate filaments
    ii. Role of motor proteins

6) Ch. 7 – Membrane structure, function and transport
a. Cell membrane structure
b. Membrane fluidity
    i. Role of cholesterol
    ii. Movement of phospholipids
    iii. Role of saturated vs unsaturated phospholipids
c. Transmembrane proteins
d. Membrane protein function
    i. Transport
    ii. Enzymatic
    iii. Signal transduction
    iv. Cell-cell recognition
    v. Intercellular junction
    vi. Attachment to cytoskeleton and extracellular matrix (ECM)
e. Membrane “sidedness”.
f. Membrane Transport
    i. Factors that affect molecule transport
        1. Size
        2. Polarity/Charge
        3. Concentration gradient
    ii. Passive transport (no energy required, down concentration gradient)
        1. Diffusion
        2. Osmosis
            a. Water potential (Go over diffusion lab)
                i. Water potential = pressure potential + solute potential

3. Facilitated transport
iii. What happens to a plant/animal cell in a hypertonic, hypotonic, isotonic solution
iv. Plasmolysis
v. Cyclosis
vi. Channel protein vs. Carrier protein
vii. Active transport (requires energy)
1. Against concentration gradient
2. Endocytosis
a. Phagocytosis
b. Pinocytosis
c. Receptor mediated endocytosis
3. Exocytosis
viii. Ion pumps
ix. Electrochemical gradient
x. Electrogenic pump
xi. Cotransport
1. Symport
2. Antiport
3. Uniport

7) Ch. 8 – Metabolism (Go over enzyme lab)
a. Metabolic pathways
b. Catabolism vs. anabolism
c. Types of energy
i. Potential
ii. Kinetic
iii. Chemical
iv. Heat
d. First law of thermodynamics
e. Second law of thermodynamics
f. Exergonic vs. endergonic reactions
g. Energy diagrams
h. ATP – structure, function, examples of when it is used, the ATP cycle, how it is used in energy transfer
i. Energy coupling
j. Redox reactions (reduction, oxidation, transfer of energy)
k. Electron carriers (NADPH, NADH, FADH)
l. Activation energy
m. Enzymes – biological catalysts that lower activation energy
i. Active site
ii. Induced fit vs. Lock and key model
iii. Effect of
1. pH
2. Temperature
3. Enzyme concentration
4. Substrate concentration
n. Cofactors vs. coenzymes
o. Competitive vs. noncompetitive inhibitors
p. Allosteric regulation of enzymes

q. Cooperativity
r. Feedback inhibition in a metabolic pathway

8) Ch. 9 – Cellular respiration (Go over cell respiration lab)
    a. Aerobic vs. Anaerobic respiration (know chemical equations, purpose)
    b. Substrate level phosphorylation vs. Oxidative phosphorylation
    c. Stages of aerobic respiration (know what enters and exits each stage)
        i. Glycolysis
        ii. Formation of Acetyl CoA
        iii. Krebs cycle (also known as citric acid cycle)
        iv. Electron transport chain (ETC)
            1. Chemiosmosis
            2. ATP Synthase
    d. Types of anaerobic respiration
        i. Lactic acid fermentation
        ii. Alcoholic fermentation
    e. What happens to the pyruvate during fermentation and why?
    f. Obligate anaerobes vs. Facultative anaerobes
    g. Catabolism of proteins, fats, carbs for energy
9) Ch. 10 – Photosynthesis (Go over photosynthesis lab)
    a. Autotrophs
        i. Chemoautotrophs vs. photoautotrophs
    b. Know chemical equation for photosynthesis
    c. Leaf anatomy (From top to bottom: cuticle, upper epidermis, palisade mesophyll, spongy mesophyll, vein with xylem and phloem, lower epidermis with stomates and guard cells)
    d. Electromagnetic spectrum
    e. Absorption spectrum
    f. Engelmann's experiment
    g. Chlorophyll a/b structure
    h. Photosystem structure
    i. Stages of photosynthesis
        i. Light dependent reactions
            1. PII (P680)
            2. PI (P700)
            3. Chemiosmosis
            4. Linear electron flow vs. Cyclic electron flow
            5. How are ATP and NADPH formed?
        ii. Light independent reaction (Calvin cycle)
            1. Carbon fixation
            2. Reduction
            3. Regeneration of RUBP (CO_2 acceptor)
            4. Rubisco (Ribulose bisphosphate carboxylase)
            5. RUBP
            6. Glyceraldehye-3-phosphate (G3P)
            7. Role of ATP and NADP
10) Ch11 – Cell Communication
    a. Local Signaling
        i. Paracrine signaling
        ii. Synaptic signaling

b. Long-Distance Signaling
    i. Hormonal signaling
c. Three stages of cell signaling
    i. Reception
        1. Membrane Protein Receptors
            a. G Protein-Coupled Receptors
            b. Receptor Tyrosine Kinases
            c. Ion Channel Receptors
        2. Intracellular Receptors
    ii. Transduction
        1. Phosphorylation cascade
            a. Protein kinases
            b. Protein phosphatases
        2. Second messengers
            a. Cyclic AMP
            b. Calcium ions
    iii. Response
        1. Nuclear responses
        2. Cytoplasmic responses
d. Amplification of cell signal
e. Specificity of cell signal
f. Apoptosis as an example of cell signaling
g. Viagra – example of cell signaling

11) Ch.12 – Cell Cycle
a. Functions of cell division
    i. Reproduction
    ii. Growth and development
    iii. Tissue renewal
b. Eukaryotic chromosome structure: histone, nucleosome
c. Chromosome
d. Chromatid
    i. Sister vs. Nonsister chromatids
e. Centromere
f. Kinetochores
g. Kinetochore microtubules
h. Non kinetochore microtubules
i. Sister Chromatids
j. Stages of cell cycle (what happens in each phase, be able to identify phases)
    i. Interphase
        1. G1
        2. S
        3. G2
    ii. Mitotic (M) phase
        1. Mitosis
            a. Prophase
            b. Metaphase
            c. Anaphase
            d. Telophase

        2. Cytokinesis
    k. Plant vs. Animal cytokinesis
        i. Cell plate vs. cleavage furrow
    l. Binary fission
    m. Cell cycle control
        i. G1 checkpoints
        ii. Growth factors
        iii. Density dependent inhibition
        iv. Anchorage dependent
    n. Cancer
12) Ch. 13 – Meiosis (Go over sordaria lab)
    a. Diploid vs. haploid
    b. Somatic vs. Sex cells (gametes)
    c. Karyotype
    d. Homologous chromosomes
    e. Tetrad
    f. Synapsis
    g. Crossing over
    h. Chiasma
    i. Recombinant chromosomes
    j. Phases of Meiosis (know what is happening in each phase, be able to identify phase)
        i. Meiosis I
            1. Prophase I (interphase precedes Prophase I)
            2. Metaphse I
            3. Anaphase I
            4. Telophase I and cytokinesis
        ii. Meiosis II
            1. Prophase II
            2. Metaphse II
            3. Anaphase II
            4. Telophase II and cytokinesis
    k. Compare mitosis with meiosis
    l. Sources of genetic variation
        i. Mutations
        ii. Crossing over
        iii. Independent assortment
        iv. Random fertilization
13) Ch. 14 – Mendel and the Gene Idea
    a. What makes a good animal model to study genetics and why?
    b. Genes
    c. Alleles
    d. Homozygous
    e. Heterozygous
    f. Genotype vs. Phenotype
    g. Law of dominance
    h. Law of segregation
    i. Law of independent assortment
    j. 3:1 ratio

k. 9:3:3:1 ratio
l. Monohybrid crosses
m. Dihybrid crosses
n. Testcross
o. Rules of probability – Addition and Multiplication
p. Complete dominance
q. Incomplete dominance
r. Codominance
s. Multiple alleles
    i. Rabbit fur color
    ii. Human ABO blood system
t. Epistasis
u. Polygenic Inheritance
v. Pleiotropy
w. Effect of environment on phenotype

14) Ch. 15 – The Chromosomal Basis of Inheritance
a. Karyotype
b. Autosomes
c. Sex chromosomes
d. Hemizygous
e. Autosomal Recessive Disorders
    i. Albinism
    ii. Cystic Fibrosis
    iii. PKU (Phenylketonuria)
    iv. Tay Sachs
f. Autosomal Dominant Disorders
    i. Achondroplasia
    ii. Huntington's Disease
    iii. Hypercholesterolemia
g. X-linked Recessive Traits
    i. Colorblindness
    ii. Hemophilia
    iii. Duchenne Muscular Dystrophy
h. Pedigrees
i. Dosage Compensation
    i. X Inactivation
        1. Barr bodies
j. Linked genes
k. Recombinants
l. Parentals
m. Recombination frequency
n. Map units
o. Meiotic Nondisjunction
    i. Aneuploidy
        1. Monosomy
        2. Trisomy
    ii. Down's Syndrome
    iii. Klinefelter's Syndrome (XXY)

iv. Turner's Syndrome (XO)

p. Polyploidy
q. Alteration of Chromosome structure
    i. Deletion
    ii. Duplication
    iii. Inversion
    iv. Reciprocal Translocation
    v. Nonreciprocal Translocation
r. Genomic Imprinting
    i. Methylation of DNA
    ii. Angelmann's syndrome vs. Prader-Willi syndrome
s. Be able to use Chi-square analysis

15) Ch. 16 – The Molecular Basis of Inheritance
a. Frederick Griffith (1928) – Transformation experiment
b. Oswald Avery, Colin Macleod, Maclyn McCarty
c. Alfred Hershey and Martha Chase Experiment (1952)
d. Erwin Chargaff – Chargaff's rules
e. Rosalind Franklin
f. James Watson and Francis Crick
g. Nucleic Acids
    i. DNA
    ii. RNA
h. Nucleotide Structure
i. DNA double helix structure
    i. Antiparallel
j. Purine vs. Pyrimidine
k. Base pairing rules
l. Three models of DNA replication
    i. Conservative model
    ii. Semiconservative model
    iii. Dispersive model
m. Matthew Meselson and Franklin Stahl
n. Semiconservative DNA Replication
    i. Origin of replication
    ii. Replication is bidirectional
    iii. Leading Strand
    iv. Lagging Strand
    v. Okazaki fragments
    vi. New strands built in 5' → 3' direction
    vii. Enzymes and proteins involved
        1. Helicase
        2. Single-strand binding proteins
        3. Topoisomerase
        4. Primase
        5. DNA polymerase III
        6. DNA polymerase I
        7. DNA ligase
o. DNA proofreading

p. Mismatch repair
q. Excision repair
r. Nuclease
s. Telomeres
t. Telomerase
u. Chromatin packing in a eukaryotic chromosome
    i. Histones
    ii. Nucleosomes
v. Euchromatin
w. Heterochromatin

16) Ch. 17 – From Gene to Protein
a. Beadle and Tatum (1941) experiment
b. Changes made to the one gene – one enzyme hypothesis
c. Central dogma of genetic information flow
    i. DNA → mRNA → protein
d. The genetic code
    i. Redundancy
e. Codon
    i. Start codon
    ii. Stop codon
f. Transcription
    i. Prokaryotic cell vs. Eukaryotic cell
    ii. Promoter
    iii. Transcription Unit
    iv. Stages of transcription
        1. Initiation
            a. Eukaryotic cell
                i. TATA box
                ii. Transcription factors
        2. Elongation
        3. Termination
g. Eukaryotic RNA processing
    i. 5' cap
    ii. 3' poly-A tail
    iii. RNA splicing
        1. Intron
        2. Exon
        3. snRNPs
        4. Spliceosomes
        5. Alternative RNA splicing
            a. Antibody variation
    iv. Ribozymes
h. Translation
    i. tRNA structure and role in translation
    ii. Anticodon
    iii. Wobble
    iv. Aminoacyl-tRNA synthetase
    v. Ribosome structure

1. Large subunit
    a. E site
    b. P site
    c. A site
2. Small subunit

vi. Stages of translation
1. Initiation
2. Elongation
    a. Codon recognition
    b. Peptide bond formation
    c. Translocation
3. Termination

i. Polyribosomes
j. Signal mechanism for targeting proteins to the ER
i. Signal peptide
ii. Signal recognition particle (SRP)
iii. SRP receptor protein
k. Point mutations
i. Base-Pair Substitution
1. Silent
2. Missense
3. Nonsense

ii. Base-pair insertion or deletion
1. Frameshift causing immediate nonsense
2. Frameshift causing extensive missense
3. No frameshift but one amino acid missing (3 base-pair deletion)

l. Mutagens
m. Coupled transcription and translation in bacteria

17) Ch. 18 – Regulation of Gene Expression
a. Negative Gene Regulation in prokaryotic cells
i. Repressible Operon
1. Trp operon
    a. Regulatory gene
    b. Promoter
    c. Repressor
    d. Operator
    e. Anabolic pathways

ii. Inducible Operon
1. Lac operon
    a. Regulatory gene
    b. Promoter
    c. Repressor
    d. Operator
    e. Catabolic pathways

b. Positive Gene Regulation in prokaryotic cells
i. Activator
ii. Positive control of lac operon by CAP “dimmer switch”

1. Lactose present, glucose scarce, cAMP level high, abundant lac mRNA synthesized
2. Lactose present, glucose present, cAMP level low, little lac mRNA synthesized

c. Regulation of gene expression in eukaryotic cells – results in differential gene expression
   i. Chromatin modification
      1. Acetylation of histone tails
      2. DNA methylation
      3. Epigenetic inheritance
   ii. Transcription
      1. Control elements
         a. Proximal control elements
         b. Distal control elements
            i. Enhancers
      2. Activators
   iii. Alternative RNA processing
   iv. Transport to cytoplasm
   v. Translation
   vi. Protein processing
   vii. Degradation of RNA
   viii. Degradation of protein
      1. Ubiquitin
      2. Proteasome
   ix. Noncoding RNA
      1. RNA interference (RNAi)
         a. MicroRNAs (miRNAs)
         b. Small interfering RNAs (siRNAs)

d. Sources of developmental information for early embryo
   i. Cytoplasmic determinants in the egg
   ii. Induction by nearby cells

e. Pattern formation
   i. Maternal effect genes
      1. Creates morphogen gradient
      2. Also called egg-polarity gene
   ii. Segmentation genes
      1. Gap genes
      2. Pair-rule genes
      3. Segment polarity genes
   iii. Homeotic genes

18) Ch. 19 – Viruses

a. Viral Structure
   i. Capsid
   ii. Capsomeres
   iii. Viral envelopes

b. Viral reproductive cycle
   i. Lytic Cycle
   ii. Lysogenic Cycle

c. Classes of Animal viruses

i. Double stranded DNA (dsDNA)
ii. Single-stranded DNA (ssDNA)
iii. Double-stranded RNA (dsRNA)
iv. Single-stranded RNA (ssRNA) – serves as mRNA
v. ssRNA (template for mRNA synthesis)
vi. ssRNA (template for DNA synthesis) – retroviruses

19) Ch. 20 – Biotechnology
    a. Cloning genes using recombinant DNA technology
        i. Reasons for cloning genes
        ii. Techniques for cloning genes – recombinant DNA technology (Go over transformation lab)
            1. Cloning a eukaryotic gene in a bacterial plasmid
                a. Role of the following
                    i. Restriction enzymes
                    ii. Plasmids as cloning vector
                    iii. Ligase
                    iv. Sticky ends vs. Blunt ends
                b. How do you know you were successful?
                    i. Role of antibiotics
        iii. Genomic library
        iv. Role of cDNA
            1. Use of reverse transcriptase
    b. Screening for clones carrying gene of interest
        i. Nucleic acid probe
        ii. Nucleic acid hybridization
    c. Polymerase Chain Reaction (PCR)
        i. When is it used and why?
        ii. Steps involved in PCR
    d. Gel Electrophoresis (Go over gel electrophoresis lab)
        i. When is it used and why?
        ii. Steps involved in gel electrophoresis
        iii. SNPs
        iv. RFLPs
    e. Southern Blotting
    f. Dideoxy chain termination method for sequencing DNA
    g. Analyzing gene expression
        i. RT-PCR analysis of expression of single genes
        ii. In-situ hybridization using probes tagged with fluorescent dyes
        iii. DNA microassay of gene expression levels

20) Review following labs
    a. Scientific method – plop, plop, fizz, fizz
    b. Diffusion/Osmosis
        i. Jello – SA/Vol ratio
        ii. Dialysis bags – various solutions inside and outside bag, water potential
    c. Enzyme – turnip peroxidase, guaiacol, colorimeter, factors affecting enzyme rate
    d. Cell respiration – use of O_2 and CO_2 probes, factors affecting cell respiration
    e. Photosynthesis – DPIP, chlorophyll extract, spectrophotometer
    f. Mitosis and Meiosis

g. Crossing over and meiosis in Fungi (sordaria)
h. Transformation
i. Gel Electrophoresis – DNA fingerprint

21) Lab skills
    a. Graphing
        i. Plotting
        ii. Analysis, finding pattern
    b. Determining rate/slope
    c. Experimental design – controls, independent variable, dependent variable, constants
    d. Tables – creating tables and reading tables
    e. Calculating mean (average)
    f. When and how to use chi-square