I. Chromosomes, The Cell Cycle and Cell Division (Chapt. 9)

A. Eukaryotic Cell Cycle
   - M – nuclear changes – distribution of chromosomes
   - G1 – first gap
   - S – DNA replication
     1 chromosome = 1 centromere
     After replication each chromosome is composed of two sister chromatids

B. Controls of the Cell Cycle
   - Checkpoints
     - G1/S – Is cell large enough?
     - External signals
       Ex = PDGF
     - Is there damage to the DNA?
     - G2/M – are all chromosomes replicated and undamaged?
   - Factors controlling cell cycle
     - Cyclins and Cdns
       - Functions - complexes
       - Changes in concentration of cyclins

C. Eukaryotic Chromosomes
   - Chromosomes vs. chromatin
   - Nucleosomes
     - Histones
   - Additional levels of condensation

D. Mitosis
   - Formation of mitotic spindle
   - Disintegration of nuclear membrane
     - By phosphorylation of the nuclear lamina
   - Spindle fibers attach to the kinetochores
     - Spindle fibers are microtubules
     - Proposed mechanism for chromosome movement
   - Chromosomes at the equator of the cell
   - Division of centromere
   - Movement to the poles
   - Cytokinesis
     - Plant cells vs. animal cells
   - Phases during mitosis
     - Prophase
     - Metaphase
     - Anaphase
     - Telophase
     - Key events during each phase

E. Meiosis
   - Goal of the process
Two consecutive divisions
   Meiosis I – describe
   Meiosis II – describe
Compare with mitosis

F. **Terms to know**
   Centrosome
   Kinetochore
   Centromere
   Chromosome
   Sister chromatids
   Diploid (2n)
   Haploid (n)
   Homologous chromosomes
   Daughter chromosomes
   Tetrad
   Synapsis

II. **DNA and its Role in Heredity (Chapt 11)**
A. **Evidence DNA is genetic material**
   Transformation experiments
   Experiments using labeled phages (T2)
B. **Structure of DNA (Watson – Crick model)**
   Two chains of nucleotides coiled to form a double helix
   Chains run in opposite directions (anti-parallel)
   Backbone (sugar – phosphate) of each chain located on the outside
   Paired bases projecting toward center
   Diameter of double helix constant (2.0 nm)
   Bases pair purine – pyrimidines
   Complementarity rule (Chargaff’s rules)
   \[
   \begin{align*}
   A &\rightarrow T \\
   G &\rightarrow C
   \end{align*}
   \]
   Each chain of nucleotides has 5’ and 3’ ends
C. **DNA replication**
   Semi-conservative
   Experimental evidence
   Bi-directional starting from an origin
   One origin in bacteria
   Multiple origins in eukaryotes
   Problems of anti-parallel strands
   DNA polymerase III
   Polymerizes 5’ to 3’
   Template has to be 3’ to 5’
   Need for a primer
   Leading strand
   Lagging strand
   Okasaki fragments
DNA polymerase I
Role in replication
Describe events at the replication fork
RNA Primase
DNA polymerase III
Helicase
Other enzymes and their functions
Ligase
Topoisomerase
Function of ss binding proteins
DNA is threaded through a replication complex
Explain
Repair mechanisms
Proof reading
Mismatch repair
Excision repair
DNA sequencing
Polymerase Chain Reaction (PCR)

III. From DNA to Protein (Chapt. 12)
A. One Gene – One Polypeptide
Experimental evidence
B. Transcription
From DNA to RNA
RNA polymerase
Polymerizes 5’ to 3’
Copies only one strand
Initiation
Elongation
Termination
C. The Genetic Code
Triple
In mRNA – three bases = 1 codon = 1 amino acid
Redundant - no internal punctuation
Start = AUG
Stop = UAA, UGA, UAG
Code is “near” universal
Translation
mRNA
Code
tRNA
Adapter molecule
Anticodon
Wobble
Function aminoacyl-tRNA synthetase
rRNA
Ribosomes
Sequence of events in building a polypeptide
   Initiation
   Elongation
      P and A sites
      Peptide bond formation
      Translocation
   Termination
D. Post-translational events
   Chemical signals
   Destinations
   Modifications
      Proteolysis
      Glycosylation
      Phosphorylation
E. Mutations
   Chromosomal mutations
   Point mutations

IV. The Genetics of Viruses and Prokaryotes (Chap. 13)
A. Life cycle of bacteriophages
   Lytic
   Lysogenic (temperate viruses)
B. Animal viruses
   Life cycle
      Naked viruses
      Enveloped viruses
         Retroviruses (example: HIV)
C. Prokaryotes
   Genetic recombination
      Conjugation
         Auxotrophic bacteria
         Prototrophic bacteria
         Description of the process
      Transformation
         Description of the process
      Transduction
         Viruses as genetic vector
      Plasmids and transposable elements
         Definitions
         Plasmids as genetic vectors
            F factors
            R factors
      Regulation of gene expression
         At the transcriptional level
            Operon concept
Structural genes
Single promoter
Operator gene
Regulatory gene
Inducible operon
lac operon
   Describe how it works
Repressible operon
trp operon
   Describe how it works?
Increasing promoter efficiency
lac operon – CRP-cAMP control