Remember: This isn’t a substitute for your notes or text. Anything covered in class (including text readings on topics we covered in class) is fair game!

**Gene Expression/Translation**
Be familiar with the course of events in each of the three phases of translation.
Be able to name the enzymes involved in each of the three phases and identify their roles (i.e., initiation factors, elongation factors, release factors).
Know the basic structure of an amino acid and a polypeptide.
Know the difference between primary, secondary, tertiary and quaternary protein structure.
Understand how codon changes can correlate with protein structure and function changes.
Understand the meaning/significance of:
- fibrous protein
- protein domain
- prion
- peptide bond
- globular protein
- PrP protein (wild type)
- proteome
- proteinogenic amino acid

Be able to read the Genetic Code.
Understand what is meant by the code being non-overlapping and non-punctuated.
Know the difference between functional and information RNA.
Which ones are which in the translational process?
Understand the basic structures and functions of mRNA, tRNA and rRNA.
Understand the sequence of events in amino acid activation.
Recognize the nomenclature used for charged and uncharged tRNA.
At what level does proofreading occur during translation? Which is read, the amino acid or the tRNA?

**Understand the meaning/significance of:**
- codon
- Wobble hypothesis
- unmixed codon family
- anticodon
- mixed codon family
- antiparallel binding of mRNA to tRNA
- nonsense codon
- “wobble” position on mRNA
- isoaccepting tRNAs

Know the basic structure and function of a ribosome and these translation-related items:
- A site small subunit decoding center AUG, UAA, UGA, UAG
- P site 16S RNA peptidyl transferase Pribnow Box
- E site Shine-Dalgarno sequence cytoplasmic vs. ER ribosomes cistron

What is peptidyl transferase? What does it do? Where is it located? Of what is it composed?
(HINT: It’s an enzyme with an RNA active site that acts as a ribozyme.)
Know the differences between prokaryotic and eukaryotic translation machinery and products.
How much energy is required to make a peptide bond?
Know the meaning/significance of these protein/polypeptide-related terms
- phosphorylation
- phosphatases
- amino acid side chain
- kinases
- ubiquitin
- protein folding machine
- phosphorylases
- native vs. nonnative configuration

**Control of Gene Expression in Microbes**
Understand what is meant by controlling gene expression at the level of transcription translation
post-transcription protein activity/function
Understand what mechanisms cells use at each of these levels (e.g., RNA hybridization, ribosome binding efficiency, codon preference, etc.)

Know the meaning/significance of:
- promoter
- inducible system
- catabolism
- positive feedback
- operator
- repressible system
- anabolism
- constitutive
- operon
- positive regulation
- attenuator control
- isomerization
- allosteric protein
- negative regulation
- repressor vs. inducer

Understand the control of expression of the lac operon and the role/significance of:
- β-galactosidase
- regulator gene (i)
- glucose
- CAP protein
- Lactose permease
- effector
- galactose
- cAMP
- Galactoside acetyltransferase
- allolactose
- cap site
- stem loop

Understand how the lac operon can be under either negative or positive control, and under what conditions
each of these controls should be in effect.

**Know** whether or not the lac operon should be transcribed when there are different combinations of sugar (lactose and glucose) in the cell.

**Understand** how arabinose itself can effect positive or negative control in the arabinose operon.

**Understand** the basic mechanisms of control in the trp operon, including attenuator control and at which level (transcription? Translation? Protein activity?) each control mechanism operates.

**Control of Gene Expression in Eukaryotes**

**Understand** what is meant by controlling gene expression at the level of transcription translation
post-transcription protein activity/function

**Understand** what mechanisms eukaryotic cells use at each of these levels (e.g., RNA interference, epigenetic markers, PEST hypothesis, N-end Rule, etc.)

**Know** the basic similarities and differences between gene expression control in bacteria and eukaryotes.

What cellular “participants” are present in both, and which are unique to each?

In each, are genes mostly turned “on” or turned “off”? Why?

**Know** the meaning/significance/roles of
enhancer transcription factor core promoter TATA box
silencer RNA polymerases I, II, III cis-acting regulatory element (DNA) DNA motif
activator nucleosome trans-acting regulatory element (DNA)
repressor histones cis-acting regulatory factor (protein)
UTR, ORF, TSS histone tail cis-acting regulatory factor (protein)
enhancerome protein domain Pre-initiation complex (PIC)

**Know** what properties a transcription factor must have to be able to assist in gene expression control.

**Understand** the mechanisms of modifying the eukaryotic primary mRNA transcript, and the significance/function of each modification.

**In terms of gene expression regulation**, understand the meaning/significance of
mRNA lifespan
codon preference
exon shuffling/alternative splicing RNA interference
transport control

**Be able to recognize** the function/roles of each of these RNAi participants:
DROSHA Argonaute protein pre miRNA RISC siRNA
Dicer double-stranded RNA miRNA RNA stem loop

**Recall** the structure of eukaryotic chromatin, and what the various components of the structure contribute to control of gene expression

**Know** the role/function/significance of the following to eukaryotic gene regulation:
nucleosome phosphorylation ubiquitin hypoacetylation
histone tail dephosphorylation hyperacetylation

**Understand** the role of DNA methylation and acetylation in gene expression control, and how it relates to epigenetic imprinting. **Consider the epigenetics videos to be required viewing!**

**Recall** the concept of genomic imprinting, and know the meaning/significance of:
paramutation monallelic inheritance atavism
epigenetic inheritance maternal vs. paternal imprinting exaptation

**Understand** how hormones can trigger signal transduction pathways that alter gene expression.

**Mutations at the Molecular Level**

**Understand** the significance of the Luria Delbruck fluctuation experiment, and what it told us about spontaneous vs. induced mutations.

**Understand** what is meant by the various types of mutations:
point insertion silent conservative missense
transition deletion synonymous nonconservative missense
transversion frameshift missense nonsense

**Understand** how mutations in non-coding regions of DNA can affect gene expression. For example, in
promoter repressor translational regulatory sites
operator intron/exon splice sites tRNA anticodon
enhancer ribosome binding sequences codon usage preference/bias

**What** is a pseudogene, and what is its significance?
Don't forget the meaning of these terms from previous lectures:
- haplosufficiency
- null mutation
- loss of function mutation
- haploinsufficiency
- leaky mutation
- gain of function mutation

Understand how mutations can also be categorized by their effect on:
- morphology
- viability
- biochemical pathways
- phenotype as affected by environment (conditional)

Know the meaning/significance of:
- forward mutation
- reverse/reversion mutation
- suppressor mutations (all types)

Know the meaning/significance of:
- totipotent
- pluripotent
- multipotent
- and which cells types are which

What would be the effect of a mutation in each type of cell?

Understand the meaning/significance/relationship of:
- germline vs. somatic mutations
- determinate (animals) vs. indeterminate (plants, fungi, protists) growth

Understand what cellular processes spread mutations in a population.

Be familiar with the concept of trinucleotide repeat mutations and their consequences.

Understand how mutations can be categorized on the basis of their effect on Darwinian fitness.

Know the meaning/significance of mutations/alleles that are adaptive, maladaptive, neutral.
- Is a silent or synonymous mutation necessarily neutral? Why or why not?
- Be able to recognize examples that illustrate this concept (e.g., Galapagos finch bills)

Recall the meaning/significance of:
- essential gene
- lethal mutation
- morphological mutation
- conditional mutant
- restrictive vs. permissive conditions
- adaptive, maladaptive, and neutral traits

**Mutagens and Repair Mechanisms**

Understand the nature of various types of mutagens and mutations that can cause mispairing during DNA replication:
- base modifying agent
- base analog
- mycotoxins
- x rays
- intercalating agent
- deaminating agent
- gamma rays
- UV radiation
- depurinating agent
- deaminating agent
- free radicals
- oxidative damage
- deamination
- depurination

Know the meaning/significance of:
- mutagen
- carcinogen
- tautomer
- pyrimidine dimer
- xeroderma pigmentosum
tautomeric shift
oxidative damage
depyrimidination
deamination
depurination

Understand the levels at which DNA repair can occur (prevention vs. post-mutation)

Know the meaning/significance/roles of the following in DNA repair:
- photolyase (which organisms use this?)
- Class I and Class I endonucleases
- AP repair
- DNA glycosylase
- post-replicative repair

Understand the mechanisms if the SOS repair system in E. coli, and why it can generate antibiotic resistance.