**FINAL ESSENTIALS**

The final exam will cover the new material specifically covered in lectures 14 (beginning with lipid biosynthesis), and lectures 16-20.

In addition, the final exam will be in part cumulative in relation to major concepts and regulation of metabolism. There will be no ΔG or ΔE calculations, only simple addition problems (e.g., how many ATPs may be generated in a certain process).

**New Material: Biosynthesis of Lipids; Metabolism of Amino Acids and Nucleotides; Hormonal Regulation**

**Concepts**
- Function of the citrate shuttle and malonyl-CoA in fatty acid biosynthesis
- Synthesis of triglycerides
- Conceptual understanding of isoprenoid structures and their synthesis
- Function of the glyoxylate cycle
- Strategies of amino acid degradation and nitrogen excretion
- Difference between glucogenic and ketogenic amino acids
- Strategies of N and S assimilation in animals, plants, and microorganisms
- General function of pyridoxal-phosphate (PLP), biotin, tetrahydrofolate (THF) and S-adenosylmethionine (SAM)
- Generation and detoxification of reactive oxygen species (ROS) as discussed in class
- Role of glutathione
- Hormonal regulation and integration of metabolism

**Enzymes/Reactions/Cofactors**
- Know key enzymes (common names only) and reactions (substrates/products, including cofactors by name or acronym) of: fatty acid biosynthesis, glyoxylate cycle, amino acid catabolism (from amino acids to urea/ammonia), nitrogen assimilation (from nitrate/nitrogen to ammonia/amino acids)
- Have general understanding of sulfur assimilation and the different strategies to synthesize Cys and Met in animals and plants
- Have general understanding of the methyl cycle and the role of SAM in metabolism
- Have general understanding of amino acid reactions (transamination, decarboxylation, hydroxylation)
- Have general understanding of nucleotide biosynthesis (purines and pyrimidines) as covered in lecture and booklet (salvage and de novo synthesis pathways)
- Have general understanding of antioxidants and detoxification reactions
- Know key enzymes and have general understanding of glycogen phosphorylase activation cascade
Structures

- Be able to recognize and to draw the structures of key urea cycle intermediates (carbamoyl-P, ornithine, arginine, urea); intermediates of nitrogen reduction (nitrate, nitrite, ammonia) and assimilation (Glu, Gln) in animals and bacteria/plants.
- Be able to recognize and to draw the structures of the following protein amino acids: Ala, Gly, Cys, Ser, Asp, Asn, Met, Lys, Glu, Gln, Arg, Phe, and Tyr.
- Be able to recognize if a compound is a pyrimidine or purine derivative.

Cumulative Material

Concepts

- General understanding of the thermodynamics of chemical reactions (as discussed in class)
- Different strategies to generate ATP (substrate-, oxidative-, and photo-phosphorylation of ADP)
- General roles of ATP-dependent phosphorylation in metabolism
- Role of “thioesters” in metabolism
- General roles of all co-factors discussed in class and be able to identify enzymes that require certain co-factors
- General and integrative understanding of the roles and subcellular localization of the major metabolic pathways (glycolysis, TCA cycle, anaplerotic reactions, gluconeogenesis, pentose phosphate pathway, Calvin cycle, synthesis and degradation of glycogen, β-oxidation of fatty acids, glyoxylate cycle, biosynthesis of ketone bodies, lipid biosynthesis, amino acid degradation, urea cycle, Cori cycle, alanine cycle, amino acid biosynthesis (as discussed in class), electron transport chain.
- General mechanisms of metabolic regulation (role of enzyme synthesis and degradation, allostery, covalent modification, futile cycling, isoenzymes, subcellular compartmentation)

Enzymes/Reactions/Structures

- Know key regulatory enzymes (common names only) and their reactions (substrates/products, including co-factors by name or acronym) of all major pathways discussed in class (e.g., PFK-1 in glycolysis, etc.).
- Know the six major classes of enzymes (be able to tell what type of enzyme catalyzes a certain reaction (e.g., is it an isomerase, transferase or lyase).
- Know structures of central intermediates (e.g. glucose, OAA, pyruvate, etc.)