Study Guide – Lehninger Principles 4th Edition

Chapter One

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Homework: 6-11. 1.1 The most powerful lesson of Biochemistry is the great similarity between all forms of life on Earth. There is basically one "operating system" and one kind of "software" – the Genetic Code – used by every organism on the planet. The only logical explanation for this similarity is **common ancestry**, which means all living things are related, far back in time. There are three domains of life, the **Eukarya** (eukaryotes), the **Bacteria** (prokaryotes), and the **Archaea**. All multicellular organisms are Eukarya, and their cells have nuclei and other structures inside. Bacteria have no nucleus and no real subcellular compartments. Archaea are single celled organisms with no nucleus which tend to be found in extreme environments like hot, acidic, or salty places. See Fig. 1-4. "**LUCA**" is the Last Universal Common Ancestor. The Earth is 4.5 billion years old and was anaerobic for about half its history, so LUCA was anaerobic. **Banded iron** formations provide evidence for the appearance of oxygen in the atmosphere (not in book, but compare Fig. 1-35).

1.2 Organic Chemistry is a prerequisite for this class. You should understand about bonds and functional groups (section 1.2 "Chemical Foundations"). Refer to online handouts including "Biochemical Scales" and "Organic Review." Biochemists generally use *D and L* instead of *R and S* to describe chiral molecules, for historical reasons.

1.3 Know that **entropy** is a measure of disorder, and that from the *Second Law of Thermodynamics* we can derive an expression for free energy change, $\Delta G = \Delta H - T\Delta S$, where H is **enthalpy** (heat content, bond energy), T is **temperature** (in Kelvins, from absolute zero), and S is **entropy**. G, the **Gibbs free energy change** is named for Josiah Willard Gibbs, and American physical chemist who worked in the 19th century. Know the calculations on page 26 which show that the equilibrium constant K_{eq} relates to the standard free energy change ΔG°. **Enzymes** are biological catalysts – they lower the activation energy and allow a reaction to reach equilibrium more quickly. They don't make unfavorable reactions go forward or add energy. Biochemical reactions often form sequences or **pathways**. **Metabolism** is made up of **catabolism** (breaking down large molecules into small ones) and **anabolism** (building larger molecules out of smaller ones). **Feedback inhibition** describes inhibition of the first step of a pathway by the product of the last step.

1.4 Except for some viruses, all organisms have genes made of DNA. Know that DNA is made of 4 kinds of nucleotides, and that messages are transcribed into RNA and then expressed (translated) as proteins. The one-dimensional gene sequence stores a three-dimensional protein structure.

1.5 You should understand Stanley Miller's experiment (Fig 1-33) and be able to diagram his apparatus. You should also know that the conditions he used did not correspond to the actual atmosphere of the early Earth. Still, reducing conditions will readily produce amino acids (but NOT nucleotides). The **RNA World** described in Fig 1-34 has serious difficulties and is unlikely to be correct. Proteins came first. Study the time-line in Fig 1-35 and the endosymbiotic theory in Fig 1-36. Know the difference between **homologs**, **orthologs**, and **paralogs**.