Question 1:
Part A: DNA, RNA and proteins are example of "large molecules". List some of the different ways through which you can substantiate the notion of "size" for each of the above molecules and characterize their average "size"

The notion of size is because of the number of the nucleotides in the DNA, RNA and proteins. There are 1000's of nucleotides that form the basis of these "large molecules".

Part B: List and briefly describe currently available techniques that allow us to determine the structure (or the atomic constitution) of such large molecules.

Question 2: What are ESTs? Why are they useful?

Expressed sequence tags (EST's) are RNA chunks that can be gathered from a cell in minute quantities, but can easily duplicated. Those chunks are very useful since they do not contain material that would be present in introns. The availability of EST databases comprising many organisms allows bioinformaticians to infer the positions on introns and even deduce alternate splicing.

ESTs can be mapped to specific chromosome locations using physical mapping techniques, such as radiation hybrid mapping, or FISH. Alternately, if the genome of the organism that originated the EST has been sequenced, one can align the EST sequence to that genome using a computer.

The current understanding of the human set of genes is solely based on EST evidence. ESTs have become a tool to refine the predicted transcripts for those genes, which leads to the prediction of their protein products and ultimately their function.

Question 3: Distinguish between metabolic pathways and signaling pathways. Research and provide an example of each of these pathways. Briefly describe how you find this information.

Metabolic Pathways are a series of chemical reactions occurring within a cell. In each pathway, a principal chemical is modified by a series of chemical reactions.

Metabolism of Glucose (Glycolysis) follows the following chemical reactions.
1. As glucose enters a cell, it is immediately phosphorylated by ATO to glucose 6-phosphate in the irreversible first step
2. In times of excess lipid or protein energy sources, certain reactions in the glycolysis pathway may run in reverse in order to produce glucose 6-phosphate which is then used for storage as glycogen or starch.
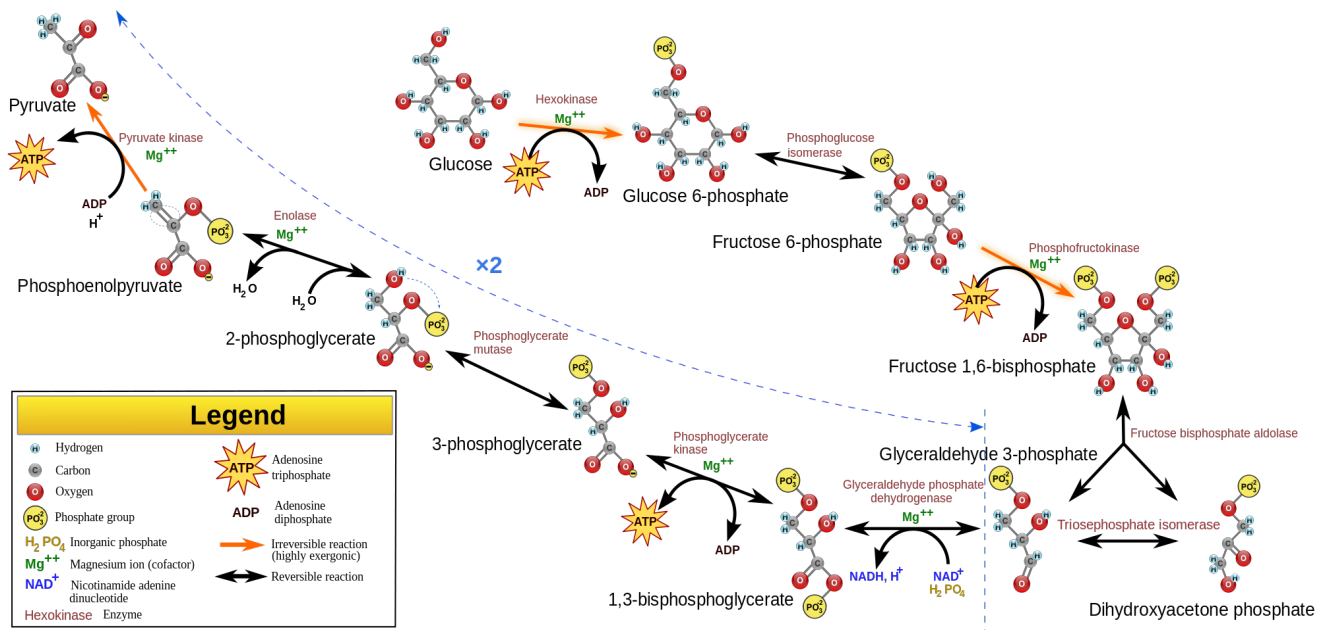
Signaling Pathways: is also a chemical reaction, but it is activated when a extracellular signaling molecule reaches cell surface receptor.

Affects of Glucagon on a rat's liver cell membrane receptor are an example of signaling pathways. Martin Rodbell noted that guanosine triphosphate disassociated glucagon from this receptor and stimulated the G-protein, which strongly influenced the cell's metabolism.
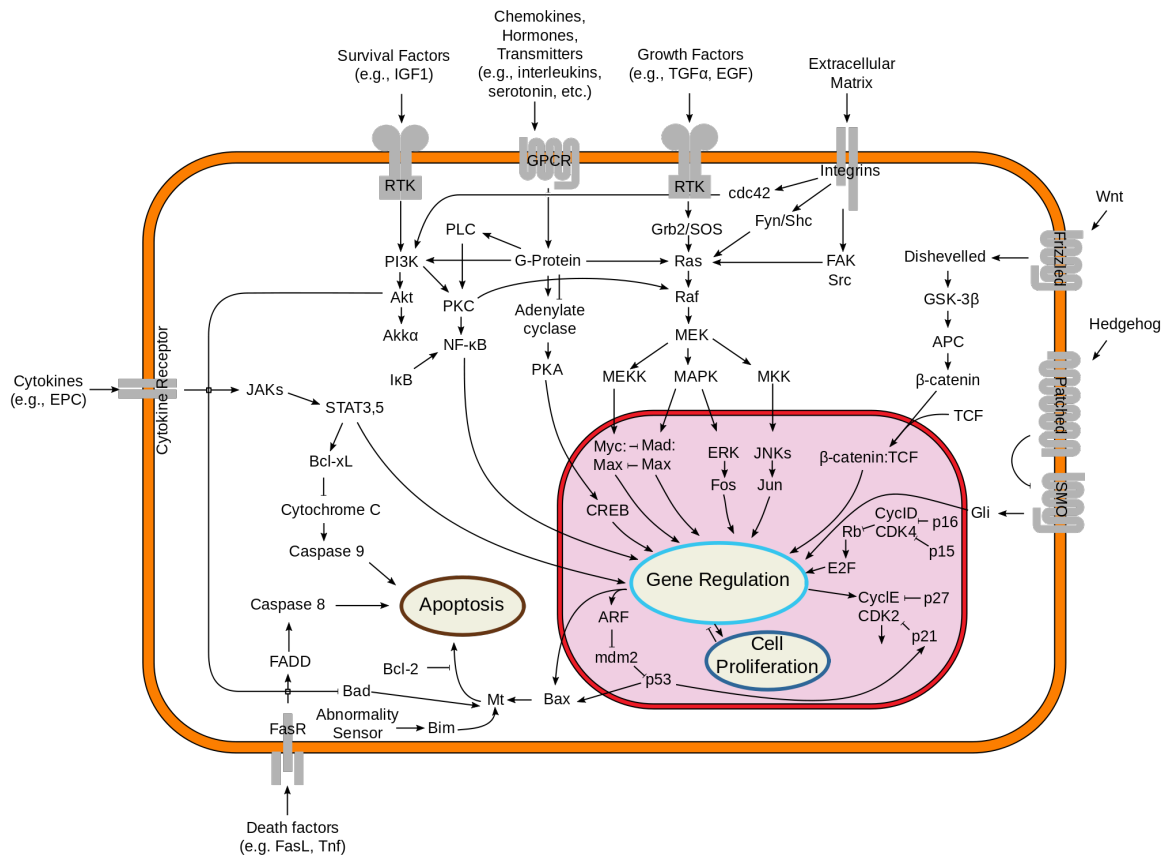
Reference:
http://en.wikipedia.org/wiki/Metabolic_pathway
http://en.wikipedia.org/wiki/Signaling_pathway

Question 4: What is two-hybrid experiment? What sort of information does it provide? What is this information important? At the state-of-the-art, what is the most common type of two-hybrid system in use?

Two-hybrid experiment is a technique to determine protein interaction. This experiments builds a huge Boolean matrix, whose rows and columns represent the proteins of a genome. If a protein interacts with another, the corresponding position in the matrix is set to true. This information can be used to reconstruct metabolic and signaling pathways.

The most common approach is the yeast two-hybrid assay. This system often utilizes a genetically engineered strain of yeast in which the biosynthesis of certain nutrients (usually amino acids or nucleic acids) is lacking. When grown on media that lacks these nutrients, the yeast fails to survive. This mutant yeast strain can be made to incorporate foreign DNA in the form of plasmids. In yeast two-hybrid screening, separate bait and prey plasmids are simultaneously introduced into the mutant yeast strain.

Question 5: What is RNAi?

RNA interference (RNAi) is a biological process in which RNA molecules regulate gene expression typically by causing the destruction of specific mRNA molecules. RNAi is an RNA-dependent gene silencing process that is controlled by the RNA-induced silencing complex (RISC) and is initiated by short double-stranded RNA molecules in a cell's cytoplasm, where they interact with the catalytic RISC component argonaute.

What are its uses?
- RNAi is used to sudy the function of genes in cell culture and in vivo model organisms. Double-stranded RNA is synthesized with a sequence complementary to a gene of interest and introduced into a cell or organism, where it is recognized as exogenous genetic material and activates the RNAi pathway. Using this mechanism, researchers can cause a drastic decrease in the expression of a targeted gene. Studying the effects of this decrease can show the physiological role of the gene product.

References:
http://en.wikipedia.org/wiki/RNA_interference