1. A pedigree is shown of 3 generations of a family in which some members were color blind for green. Those afflicted are shown with darkened symbols. One female marked with an asterisk (*) in the F-1 also had children (father unknown) but none were color blind. (10 pts)
   a. Which type of chromosome carries the gene? _X_____
   b. Is it dominant or recessive? __Recessive________
   c. What is the genotype of afflicted individuals? _recessive gene (X mutant)/Y or no Y _______
   d. Which individuals (mark them with an X in the box or circle of the diagram) must be carriers of the gene? (F-1 females on the two ends)

2. Make some predictions from the following cross between true breeding strains of pea plants (8 pts).
   The phenotype of one parent yellow pods and Tall stems. The genes are designated g and T.
   The phenotype of the other parent is green pods and dwarf stems. The genes are designated G and t.
   a. What is the genotype of the F-1? GgTt

2pts
   e. Suggest a molecular technology that might be able to diagnose whether a person is a carrier or not? _____PCR, or DNA sequencing_______

b. If the G and T genes are not linked, what are the genotypes of the gametes that are produced by the F-1? GT, gT, Gt, gt
c. If the G and T genes are linked, and if there is no crossing over, what would be the genotype of the gametes that are produced by the F-1? Gt, gT

d. If G and T are dominant over g and t, what is the phenotype of the F-1? Green and Tall

3. Define only six (6) of the following terms. choose any 6 from the list. Give a brief, one or two sentence definition that clearly describes the meaning of the term. (5 pts @ for 30 pts)

   a) polygenic trait   A phenotype in which two more different genes govern/influence final phenotype. Eye color, skin color, etc. would be examples.

   b) restriction enzyme   An enzyme that cleaves double stranded DNA at a specific sequence (often a hexamer)

   c) plasmid    A small "virus-like" circular DNA resident in many bacteria, distinct from the bacterial DNA/chromosome proper. Has very few genes. Can encode drug resistance.

   d) autosome   Any chromosome that is not a sex chromosome, not X or Y

   e) enhancer   A transcription factor, protein, that binds to specific DNA sequences and affects transcription at the promoter positively.

   f) Chargaff’s rule    Composition of DNA always has proportions of A=T, G=C.

   g) adaptor RNA (tRNA) A small RNA that binds a specific amino acid at one end and possesses the cognate anti-codon for that amino acid in the middle.

h) penetrance: an all or none property of an allele indicating whether the phenotype
actually manifests itself.

4. A list of 7 different propositions appears below. They are all either false or at least questionable. Choose 5 of them, analyzing why they are incorrect or questionable. For each answer, briefly (in a sentence of two) give the evidence, example, or reasoning to support your opinion. (6 pts @ for 30 pts).

   a. Selective DNA replication is the basis of differential gene expression
   No, differential gene expression comes from regulation at the promoter, whether it is transcribed or not, which can be influenced by other transcription factors, and "environmental" factors acting on TF's.

   b. A significant similarity between mitosis and meiosis is that in both instances DNA replication precedes cytokinesis (actual cell division). NO, in Meiosis there is only one replication prior to the first cell division, but the second occurs without an antecedent S period.

   c. A retrovirus contains a single stand of DNA. Retroviruses, by definition, have only a single stranded RNA genome.

   d. The PCR reaction requires two primers and DNAse. While 2 primers are required, DNAse would be a disaster, hydrolyzing the products. It's DNA polymerase that's required.

   e. The codon for methionine in the mRNA must exactly match the anti-codon in the cognate tRNA. No, not match, be complementary. For examples, The methionine codon is AUG, so the tRNA must possess the UAC anticodon.

   f. The genetic code is triplet, non-redundant, and universal. It IS redundant.

Name:__________________
g. Regulatory regions of a gene (enhancer or suppressor binding sequence) directly control mRNA stability. No, they are just binding sites for TFs, which influence rates of Trx.

5. The following terms refer to different steps in the flow of information from the DNA of the gene to the formation of phenotypes. Place the numbers from the list in the correct order beginning with DNA. (7 pts)

DNA _____ 6 (2) _____ 7 1 3 5

1) binding to ribosome, 2) splicing, 3) translation termination, 4) transcription, 5) post-translational modification, 6) modification of pre-mRNA (nascent transcript) 7) export from nucleus.

6. Write a short paragraph explaining the two main functions of a gene. (Hint: By definition, genes are sequences of DNA, but what we are asking here is the big picture of what these pieces of DNA do for an organism and how they do it. (15 pts).

1) Heredity. This works by DNA strand separation and high fidelity copying of both strands. Each replicated DNA is composed of one parent strand and a new complementary strand. The two daughter DNA molecules (daughter chromosomes) are then accurately sorted and distributed to the two daughter cells in mitosis. In sexual reproduction, meiosis ensures that each one allele of each gene is passed to a gamete.

2) Instruction booklet for phenotype. This works as specified in the Central Dogma: one strand of the DNA is transcribed, processed as described in question 5, and the complementary mRNA is translated, codon by codon, with the ribosomes and enzymes. It's the protein, which may be modified (by enzymes encoded by other genes), that then, in combination with partner proteins/structures that determines phenotype.