Name: _____

7.012 Exam One -- 2006

Exam starts at 10:05 am and ends at 10:55 am.

There are 10 pages including this cover page.

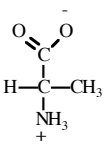
Please write your name on each page.

Only writing on the **FRONT** of every page will be graded.
(You may use the backs, but only as scratch paper.)

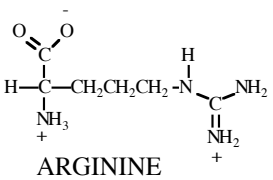
Question 1	**21 pts_____**
Question 2	**35 pts_____**
Question 3	**14 pts_____**
Question 4	**30 pts_____**
TOTAL	**out of 100_____**

Name: _____

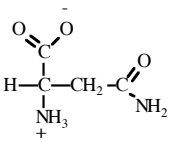
at pH 7.0



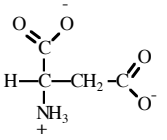
ALANINE
(ala)



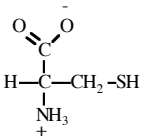
ARGININE
(arg)



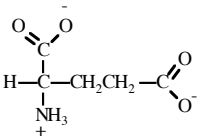
ASPARAGINE
(asN)



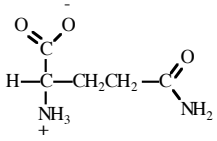
ASPARTIC ACID
(asp)



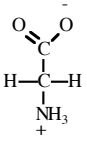
CYSTEINE
(cys)



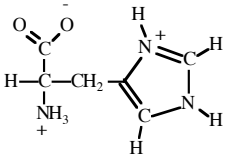
GLUTAMIC ACID
(glu)



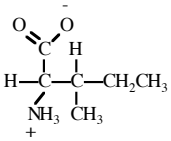
GLUTAMINE
(glN)



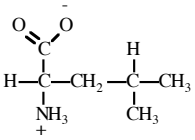
GLYCINE
(gly)



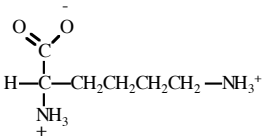
HISTIDINE
(his)



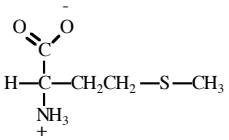
ISOLEUCINE
(ile)



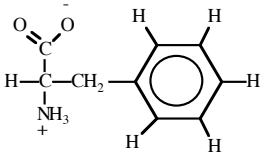
LEUCINE
(leu)



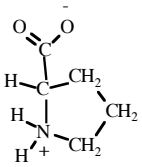
LYSINE
(lys)



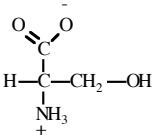
METHIONINE
(met)



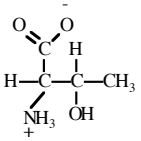
PHENYLALANINE
(phe)



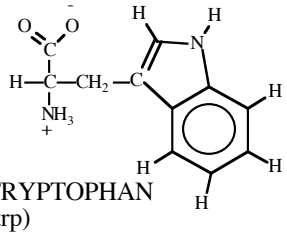
PROLINE
(pro)



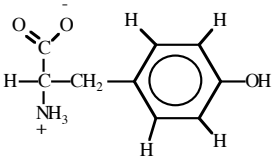
SERINE
(ser)



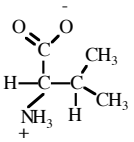
THREONINE
(thr)



TRYPTOPHAN
(trp)



TYROSINE
(tyr)



VALINE
(val)

Name: _____

Question 1. **(21 pts)** You are studying a di-peptide with the sequence N-asp-ser-C.

(a, 4 pts) Draw the structure of this di-peptide at pH7.

(b, 4 pts) Draw the structure of this di-peptide at pH7 if it had been phosphorylated on one of its R groups.

Name: _____

(c, 8 pts) If an interaction occurred between two proteins via each pair of the following amino acids, what is the strongest type of bond that would form between the amino acids of each pair? Your choices are: Hydrogen bond, ionic bond, hydrophobic effect, covalent bond, and van der Waals force.

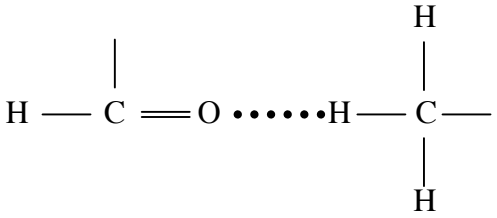
(i) Cys and cys

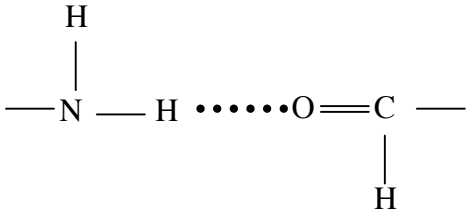
(ii) Tyr and his

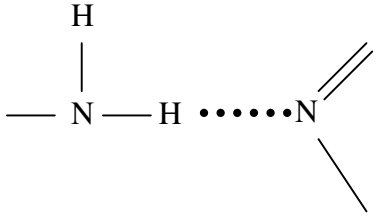
(iii) Phe and arg

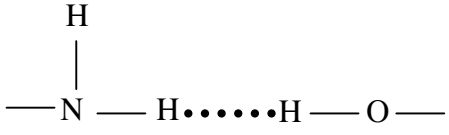
(iv) Phe and val

(d, 5 pts) Which of these is a Hydrogen bond that is correctly drawn? Of the four options below, circle **all** that are correctly drawn. The series of dots (••••••) indicate hydrogen bonds.









Name: _____

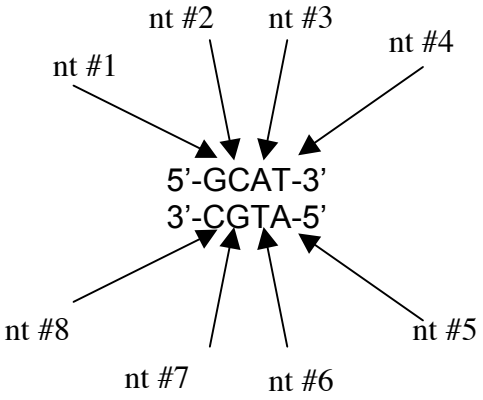
Question 2. (35 pts) You imagine that not all life forms (if you include viruses and aliens) must have double-stranded DNA molecules as their genetic material. Theoretically, a life form could have a genome made of:
single-stranded DNA, single-stranded RNA, double-stranded DNA, double-stranded RNA, or a hybrid of one strand of RNA with one strand of DNA. Which type of genome is each of these life forms most likely to have?

(a, 3 pts) genome = 26%G, 6%T, 26%C, 18%U, 24%A

(b, 3 pts) genome = 15%G, 0%T, 15%C, 35%U, 35%A

(c, 3 pts) genome = 31%G, 19%T, 19%C, 0%U, 31%A

In the following sequence:



(d, 3 pts) Which of these nucleotides would have a free triphosphate group extending from one of the carbons of their sugar? List the nucleotides by the numbers (nt #1 – nt #8) with which they have been labeled.

(e, 3 pts) Which of these nucleotides would have a free hydroxyl group extending from one of the carbons of their sugar? List the nucleotides by the numbers (nt #1 – nt #8) with which they have been labeled.

Name: _____

You discover a new protein in *E. coli* that you believe has both a transmembrane domain and a domain that binds to DNA. Below is shown part of this protein's sequence:

N… Ala-Leu-Phe-Ala-Gly-Ile-Val-Glu-Asn-Ser-Thr-Ala-Asp-Trp-His-Arg-Lys-His-Arg…C

(f, 5 pts) List the continuous set of amino acids that would be most likely be a part of the transmembrane domain. State why you chose that stretch of amino acids.

(g, 4 pts) You discover experimentally that your hypothesis that this protein is a transmembrane protein is not correct; it is a protein that resides in the cytoplasm. Where in the 3-dimensional structure of this protein do you think you would find the amino acids you listed in part **(f)**?

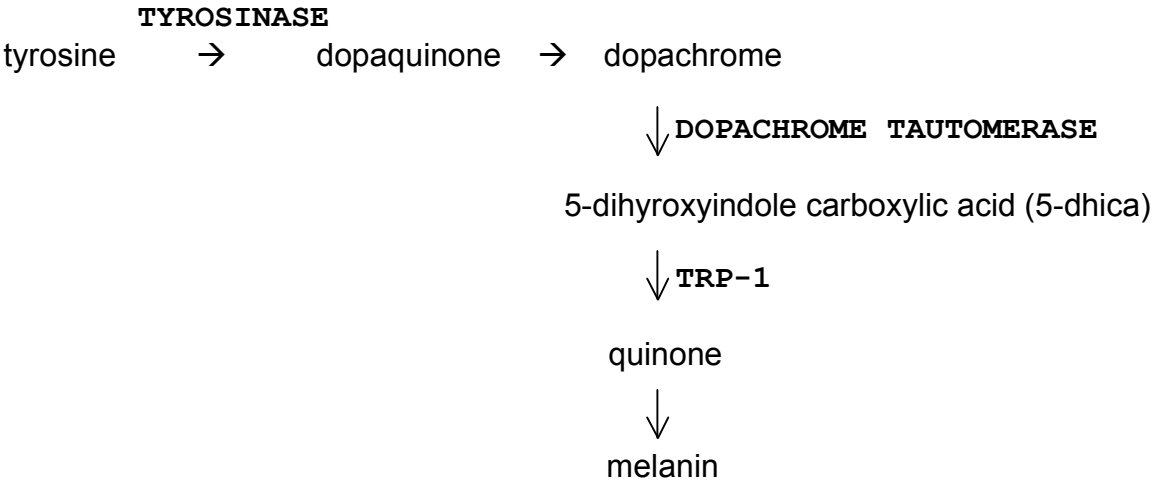
(h, 5 pts) List the continuous set of amino acids that would be most likely to bind and interact with DNA. State why you chose that stretch of amino acids.

(i, 3 pts) Do you think those amino acids are more likely to interact with the bases of the DNA or the backbone?

(j, 3 pts) What is the strongest bond that would form between this protein and the DNA to which it can bind? Your choices are: Hydrogen bond, ionic bond, hydrophobic effect, covalent bond, and van der Waals force.

Name: _____

Question 3. (14 pts) The following is a biochemical pathway involved in converting tyrosine (an amino acid) into melanin (the pigment that colors our skin). Humans who lack melanin have albinism and thus lack pigment. The pathway is shown with the compounds in lowercase, and three of the enzymes that operate in this pathway in **UPPERCASE**.



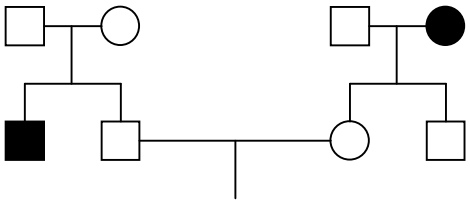
(a, 4 pts) Albinism is always recessive. Why do you think it is recessive?

There are different forms of albinism; all are very rare. People with albinism who accumulate tyrosine have a form of albinism that is autosomal. People with albinism who accumulate dopachrome have a form of albinism that is autosomal. People with albinism who accumulate 5-dhica have a form of albinism that is sex-linked.

(b, 5 pts) Given this information, what can you conclude regarding the genes encoding **TYROSINASE** and **TRP-1**, in terms of linkage? Are they linked, unlinked, both, neither, or is it inconclusive?

Name: _____

Answer part **(c)** using the following pedigree.



?

(c, 5 pts) Assume that the two families that join at the bottom of this pedigree are unrelated. The family on the left has a son who has albinism and accumulates **tyrosine**. (Assume this son contains a defect in only one enzyme in the pathway shown above.) The mother of the family on the right has albinism and accumulates **dopachrome**. What is the chance that the child indicated by a question mark will have albinism?

Question 4. (30 pts) The following is a biochemical pathway involved in producing a pigment that makes a particular animal's fur green. Gene A encodes Enzyme A. Gene B encodes Enzyme B. Gene C encodes Enzyme C. A^- or B^- or C^- indicates a mutant allele that eliminates function of the gene and causes a recessive phenotype.

Blue precursor $\xrightarrow{\text{Enzyme A}}$ Red precursor $\xrightarrow{\text{Enzyme B}}$ brown precursor $\xrightarrow{\text{Enzyme C}}$ green pigment

(a, 2 pts) What would the phenotype of a B^-B^- animal be?

(b, 2 pts) What would the phenotype of a C^-C^- animal be?

(c, 2 pts) What would the phenotype of a B^-B^- C^-C^- animal be?

Name: _____

(d, 6 pts) If you mated an B^+B^- C^-C^- animal to an B^+B^- C^+C^- animal, what classes of offspring would you get out, and in what ratio? Answer using a phenotypic ratio. Assume Gene B and Gene C are on different autosomes.

(e, 8 pts) If you mated an B^+B^- C^-C^- animal to an B^+B^- C^+C^- animal (named Scruffy), which phenotypic classes of offspring would you get out, and how many offspring would in each class if there were 1000 total offspring? In this part, now assume Gene B and Gene C are 10cM apart on the same autosome. Also assume that the parents of Scruffy were true-breeding; one was brown and the other was red.

Name: _____

$A1^{-}$ and $A2^{-}$ are two different mutant alleles of the same gene (gene A), and that gene lies on the X chromosome. (Assume this animal's gender is determined in the same way as humans.) Each mutation alone eliminates the function of the gene and causes a recessive phenotype.

Blue precursor $\xrightarrow{\text{Enzyme A}}$ Red precursor $\xrightarrow{\text{Enzyme B}}$ brown precursor $\xrightarrow{\text{Enzyme C}}$ green pigment

(f, 2 pts) What would the phenotype of an $X^{A1^{-}}X^{A1^{-}}$ animal be?

(g, 2 pts) What would the phenotype of an $X^{A2^{-}}X^{A2^{-}}$ animal be?

(h, 6 pts) If you mated an $X^{A1^{+}}X^{A1^{-}}$ animal to an $X^{A2^{-}}Y$ animal, what classes of offspring would you get out, and in what ratio? Answer using a phenotypic ratio. State a separate phenotypic ratio for sons and for daughters.