# 7.012 Quiz 1 Answers

| | |
|---|---|
| A≥87 | ~25% of test takers |
| **B≥73** | **~34% of test takers** |
| **C≥60** | **~24.3% of test takers** |
| **D≥50** | **~10.1% of test takers** |
| F≥49 | ~6.5% of test takers |

**Regrade requests (with a note attached indicating the problem and part you want looked at)**

Monday 10/04/04

| Question | Value | Score |
|---|---|---|
| 1 | 16 | |
| 2 | 20 | |
| 3 | 16 | |
| 4 | 16 | |
| 5 | 15 | |
| 6 | 17 | |
| | 100 | |

**Question 1**

a) Match each boxed chemical interaction in the structures below with the appropriate description. 10 pts

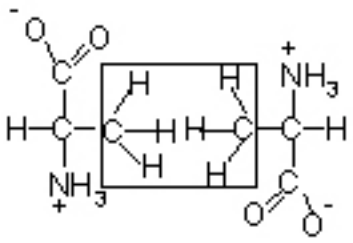
_____B_____ peptide bond

_____E_____ ionic bond

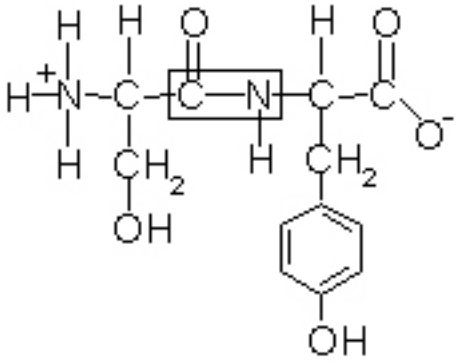
_____A_____ van der Waal's interaction

_____D_____ phosphodiester bond

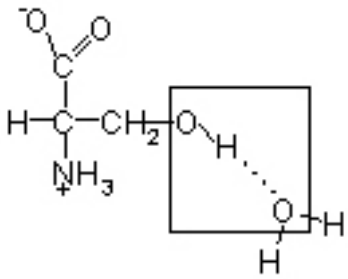
_____C_____ hydrogen bond



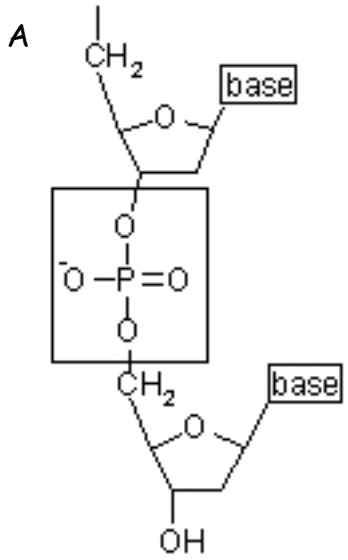
A



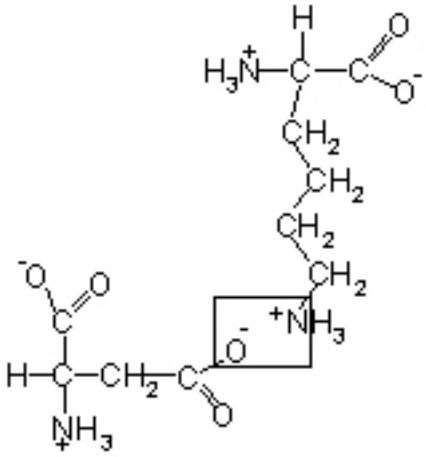
B



C




D



E

Name_____

b) Which one of the following structural features is NOT based on hydrogen bonds? Circle all that apply. 3 pts

i) complementary base pairing in DNA

ii) protein primary structure

iii) protein secondary structure

iv) complementary base pairing in RNA

c) Your friend tried to remove some writing on a plastic box. He used a napkin dampened with water, which did not work. Then as you advised, he used ethanol (instead of water), and successfully removed the writing. Circle why ethanol was **better** than water in this case. 3 pts

**[formula of ethanol: $CH_3$-$CH_2$-OH]**

i) Ethanol has a greater surface tension, so it extracts the ink molecules better from the plastic.

ii) Ethanol can form hydrogen bonds with the ink molecules.

iii) One end of ethanol is non-polar. This makes ethanol a better solvent for the ink molecules.

iv) Ethanol is more hydrophilic, so it washes off the writing more efficiently.

**Question 2**

**a) Fill in the percentages. If the value can't be determined write "ND". 6 points**

i) According to Chargaff's rule, if the DNA content of a cell was composed of 15% A, then C would make up _____**35**_____% , G would make up ___**35**_____%, and T would make up____**15%**_____ % of the cell's DNA.

ii) If the RNA content of a cell was composed of 15% A, then C would make up _____**ND**_____%, G would make up _____**ND**_____%, and T would make up____**0%**_____ % of the cell's DNA.

b) Match the following with all that apply. **6 points**

| | | |
|---|---|---|
| ___**ace**___ | Lactase | A. Lowers the activation energy of a reaction |
| | | B. Raises the activation energy of a reaction |
| | | C. Breaks down milk sugar to galactose and glucose |
| _____**ag**___ | ribozyme | D. Lipid |
| | | E. Protein |
| ___**f**_____ | "The Transforming Principle" | F. DNA |
| | | G. RNA |

**c) Fill in the blanks. 2 pts each**

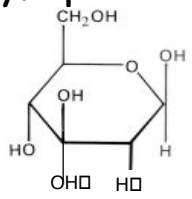
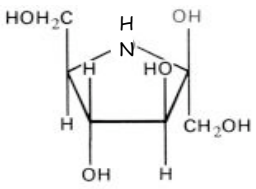
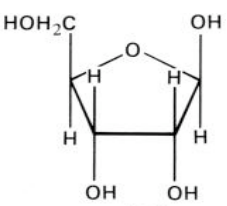
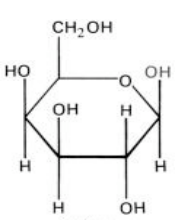
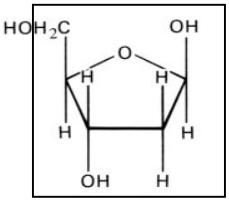
i) DNA is synthesized in the _____ direction. Circle one.

C→N  3'→5'  O→P  N→C  **[5'→3']**  P→O

ii) Proteins are synthesized in the _____ direction. Circle onel.

C→N  3'→5'  O→P  **[N→C]**  5'→3'  P→O

**d) Which of the following is used to make deoxyribonucleic acid? Circle all that apply.4 points**

Name_____

**Question 3**

Eukaryotes have proteins called histones that are involved in tightly packing DNA. Below is a schematic of the interaction between a molecule of DNA and the surface of a histone protein. "X" represents an amino acid side chain sticking out from the surface of the protein towards the DNA backbone.

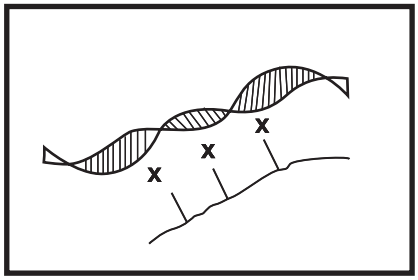



Figure by MIT OCW.

a) Circle the type(s) of amino acids you would expect to find with side chains in the positions marked "**X**"?

negatively charged | non-polar | **positively charged** | hydrophobic

2 pts.

b) Circle the **strongest** interaction between the DNA backbone and the histone protein.

hydrogen | **ionic** | van der Waals | X-linked

2 pts

Eight histone proteins function as subunits in a multi-protein complex called a nucleosome. Portions of two subunits (HA and HB) interact in the core of the nucleosome. The figure below shows the $\alpha-$ helices where these two proteins interact.

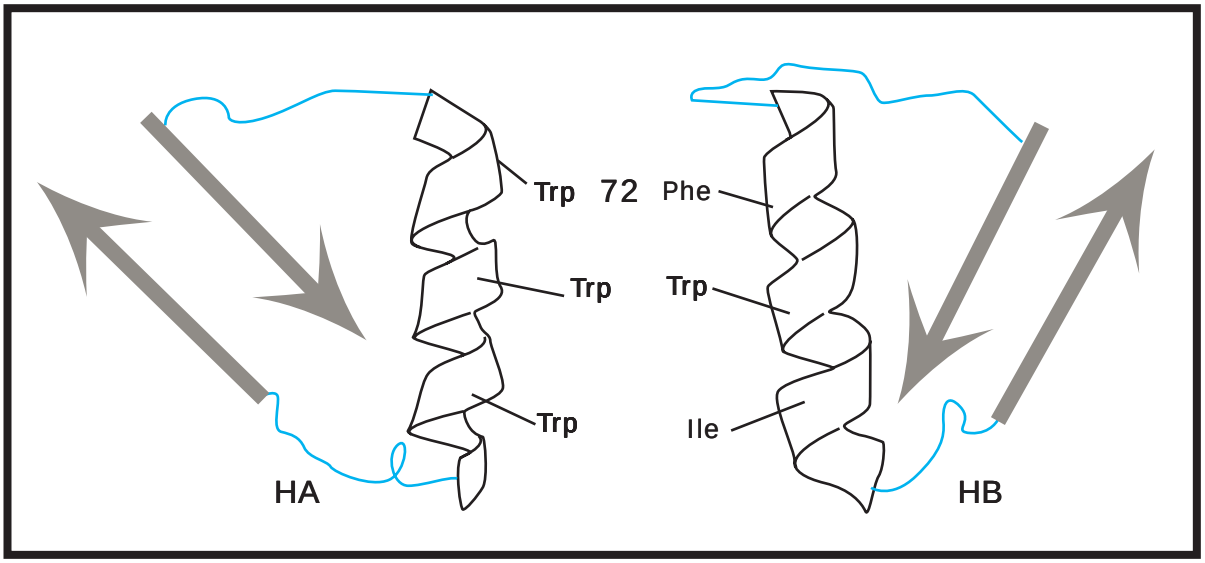



Figure by MIT OCW.

c) Based on the amino acids labeled in the diagram, what interactions keeps HA and HB together? Circle all that apply. 3 pts

covalent hydrogen **hydrophobic** ionic **van der Waals**

d) If tryptophan 72 mutates to become an arginine residue, indicate how the interaction between HA and HB would change. 2 pts.

becomes stronger **becomes weaker** remains the same can not be determined

e) Explain your answer in d) in twelve (12) words or less. 3 pts

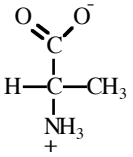
**Positive charged does'nt interact with hydrophobic side chain.**

f) Based on the information given, circle **all** levels of structure possessed by histones within a nucleosome. 4 pts

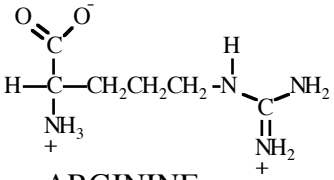
| primary | secondary | tertiary | quaternary | quinternary |
|---|---|---|---|---|

Name_____

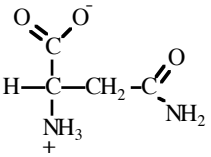
# STRUCTURES OF AMINO ACIDS at pH 7.0



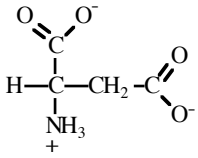
ALANINE
(ala)



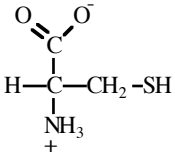
ARGININE
(arg)



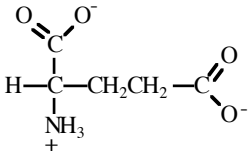
ASPARAGINE
(asn)



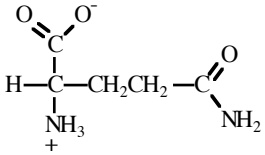
ASPARTIC ACID
(asp)



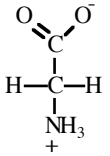
CYSTEINE
(cys)



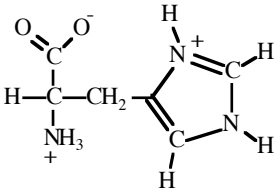
GLUTAMIC ACID
(glu)



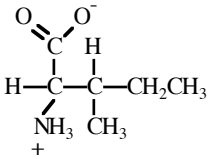
GLUTAMINE
(gln)



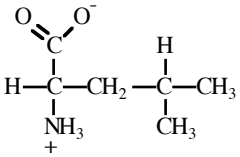
GLYCINE
(gly)



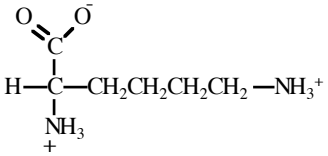
HISTIDINE
(his)



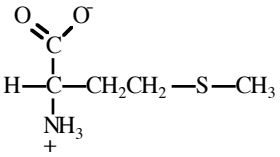
ISOLEUCINE
(ile)



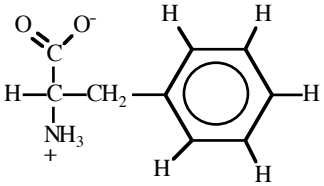
LEUCINE
(leu)



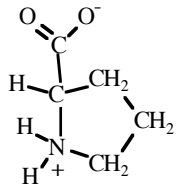
LYSINE
(lys)



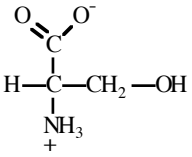
METHIONINE
(met)



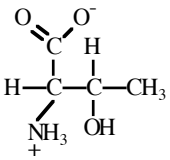
PHENYLALANINE
(phe)



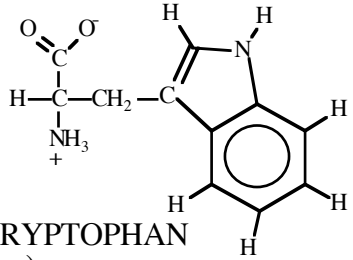
PROLINE
(pro)



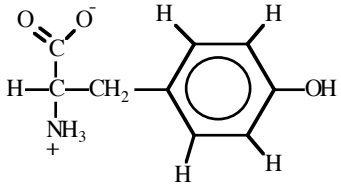
SERINE
(ser)



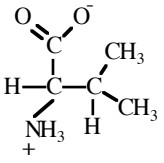
THREONINE
(thr)



TRYPTOPHAN
(trp)



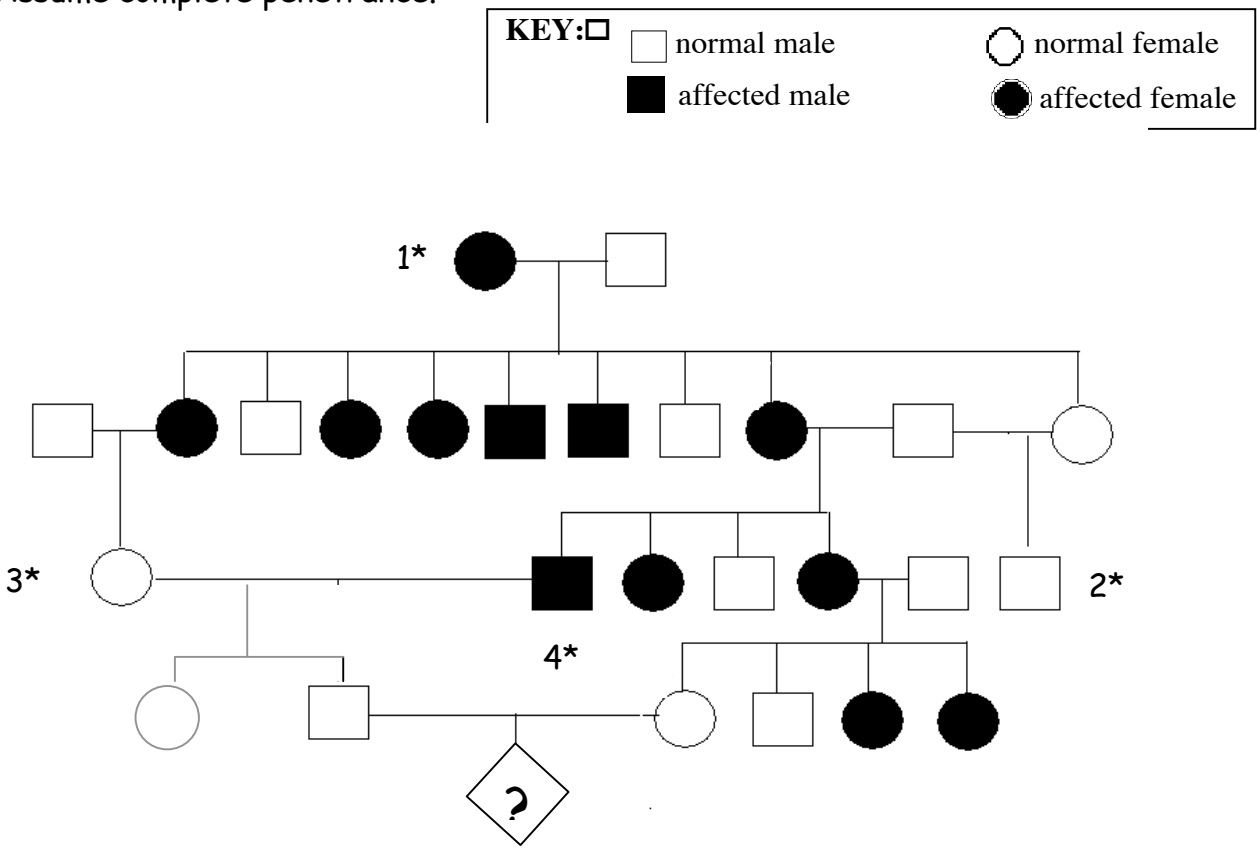
TYROSINE
(tyr)



VALINE
(val)

**Question 4**

Polydactyly is a trait where an individual develops more than five fingers per hand or toes per foot. The pattern of inheritance of polydactyly is shown in the following pedigree. Assume that all individuals marrying in from outside the family do not carry a disease allele. Assume complete penetrance.




a) What is the mode of inheritance of this trait? Circle all that apply. 4 pts

Autosomal Dominant Mitochondrial Recessive

Sex-limited X-linked Y-linked

b) What are the genotypes of the numbered individuals? If more than one genotype is possible, write all. Only show the genotype relating to the disease phenotype. Use the letters D, d, $X^D$, $X^d$, $Y^D$, $Y^d$, $M^D$ or $M^d$ to indicate the genotype corresponding to the polydactyly alleles. 8 pts

1*_____**Dd**_____ 2*_____**dd**_____ 3*____**dd**_____ 4*_____**Dd**_____

c) What is the probability that the unborn individual marked with (?) will have polydactyly, 4 pts

if it were male?___**0%**_____ if it were female?_____**0%**___

Name_____

**Question 5**

You are studying flies with different eye colors, so you cross them to determine the mode of inheritance. **Using standard nomenclature,** fill in the blanks with all possible genotypes of the flies described. Use the letters B, b, G, g, H, h, A, a , R and/or r to designate the alleles. If sex chromosomes are involved, use the format →$X^B$, $X^b$, $X^G$, $X^g$, $Y^B$, $Y^b$, etc. 7 pts

a) $F_0$: Black-eyed flies _____ gg__ x Gray-eyed flies__ Gg_____

↓

$F_1$ 253 Black-eyed flies____ gg _____

228 Gray-eyed flies_____ Gg_____

Gray-eyed flies x Gray-eyed flies ($F_1$ flies)

↓

$F_2$ 138 Black-eyed flies _____ gg_____

284 Gray-eyed flies _____ Gg_____

124 Hazel-eyed flies _____ GG_____

---

b) $F_0$: Amber-eyed male flies ___$X^r$ Y__ x Red-eyed female flies ___$X^RX^R$_ 8 pts

↓

$F_1$:

All red-eyed __$X^RXr$, $X^RY$_____

Red-eyed male $F_1$ x Red-eyed female $F_1$

↓

$F_2$ 354 Red eyed males_____$X^RY$_____

355 Amber-eyed males_____$X^rY$_____

706 Red-eyed females___$X^RX^R$, $X^RXr$____

**Question 6**

You have a strain of yeast that glows purple when compound A is added to the medium. You suspect that compound A is a precursor of the "glowing" pathway. You mutagenize the original haploid strain and isolate six mutants that do not glow purple in the presence of compound A.

Since haploid yeast can be mated to make diploids, you mate each mutant strain with your original WT purple yeast to determine whether the mutant phenotypes are dominant or recessive. You also mate each mutant strain with each other to see which strains can complement each others' phenotypes. The results are summarized below.

**("+" means colonies glow purple, "-" means they do not glow purple)**

| Strains Mated | m1 | m2 | m3 | m4 | m5 | m6 | WT |
|---|---|---|---|---|---|---|---|
| m1 | - | - | + | + | + | - | + |
| m2 | | - | + | + | + | - | + |
| m3 | | | - | + | - | + | + |
| m4 | | | | - | + | + | + |
| m5 | | | | | - | + | + |
| m6 | | | | | | - | + |

a) Are all the mutant phenotypes recessive? Yes. No. 2 pts.

If no, indicate the mutants having dominant phenotypes.

b) Place the mutants into complementation groups. 6 pts

**m1 m2 m6** **m3 m5** **m4**

c) How many genes have you identified that are involved in this pathway? 2 pts

**3**

Name_____

In the presence of compound A, the different mutants glow different colors (other than purple). You suspect that these colors may be due to a buildup of different compounds in a biochemical pathway. To figure out this novel biochemical pathway, you make the following observations.

- When you add compound A to mutant 1, the strain accumulates compound R and glows red.
- When you add compound A to mutant 4, the strain accumulates compound B and glows blue.
- When you add either compound B or R to Mutant 5, the strain glows purple.
- When you add compound A to a double-mutant yeast strain having both Mutation 2 and Mutation 4, it glows blue.

Based on these results solve the biochemical pathway.

Circle the model that is consistent with your epistasis data. Note that "Enz 1" denotes the enzyme encoded by the gene mutated in the m1 strain.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Model 1** | Compound A | Enz 5 → | Compound B | Enz 4 → | Compound R | Enz 6 → | Purple | |
| Model 2 | Compound R | Enz 2 → | Compound B | Enz 5 → | Compound A | Enz 4 → | Purple | |
| Model 3 | Compound A | Enz 4 → | Compound R | Enz 2 → | Compound B | Enz 5 → | Purple | |
| Model 4 | Compound A | Enz 1 → | Compound R | Enz 5 → | Compound B | Enz 4 → | Purple | |
| Model 5 | Compound A | Enz 5 → | Compound R | Enz 4 → | Compound B | Enz 3 → | Purple | |
| Model 6 | Compound A | Enz 3 → | Compound R | Enz 6 → | Compound B | Enz 4 → | Purple | |

**7 pts**