Biology 113 Closed Book Take-Home Exam #2 – Chapters 4 - 7

There is no time limit on this test, though I have tried to design one that you should be able to complete within 3 hours. There are 7 pages in the exam, including this cover sheet and the data gallery. You are <u>not allowed to look at someone else's test, nor use your notes, old tests, the internet, any books, nor are you allowed to discuss the test with anyone</u> until all exams are turned in no later than **8:30 am on Monday Oct. 17**. If you turn in your exam late, you will lose a letter grade for each day you are late. The **answers to the questions must be typed in this Word file** unless you are asked to draw on a separate page, or you want to use scratch paper. If you do not write your answers in the appropriate location, I may not find them. Tell me where to look if you put your answer at the back of your test.

I have provided you with a "Data Gallery" in the form of figures and tables. To choose a figure in support of your answer, simply state Figure #x. You do NOT need to move the figure on your test. Do not assume how many of the data images you will use, or not use. **Simply choosing the data is not sufficient support for your answer. You must explain the significance of the data and how they support your answer.** I have given you sentence limits so be concise.

-3 pts if you do not follow this direction.
Please do not write or type your name on any page other than this cover page.
Staple all your pages (INCLUDING THE TEST PAGES) together when finished with the exam.

Name (please print):

Read the pledge and sign if you can do so with honor:

_____

On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.

How long did this exam take you to complete?

<u>Lab Questions:</u>

6 pts.

1) Here are two ApE questions.

a) How many SNPs are present in the 4 sequences called (SNP1, SNP2, SNP3, SNP4)? Support your answer with a screenshot as evidence.

screenshot here: 3 SNPs

b) You have two files called Carify_Bases.ape and Carify_Bases.ab1. Open the .ape file and locate all the N bases (check the box that says "as literal" to find the Ns). Use the chromat file to override any of the N bases. When you have your corrected sequence, copy and paste the sequence in the space below. Please format the remaining **N bases in bold** and the <u>corrected bases in underline</u> to make it easier for me to see your answer.

```
Paste here:
```

ATCGATGAGCTGACCCGATCGCCGCCGCCGG<u>A</u>GGGGTTGCGTTTGAGACGGGCGACAGATGAATTCGCGGCCGCTTCT

AGAGTTGACAATTAATCATCCGGCTCGTAATTTATGTGGACGACGACTCACTATAGGTACCGGTGA**NNN**CAGCATCG

TCTTG**N**TGCCCTTGGCAGCACCCTGCTAAGGAGGTAACGCGGAGATGGGACTTAAATCTAACAATGCGCTCATCGTC

ATCCTCGGCACCGTCACCCTGGATGCTGTAGGCATAGGCTTGGTTATGCCGGTACTGCCGGGCCTCTTGCGGGATAT

CGTCCATTCCGACAGCATCGCCAGTCACTATGGCGTGCTGCTAGCGCTATATGCGTTGATGCAATTTCTATGCGCAC

CCGTTCTCGGAGCACTGTCCGACCGCTTTGGCCGCCGCCCAGTCCTGCTCGCTTCGCTACTTGGAGCCACTATCGAC

TACGCGATCATGGCGACCACACCCGTCCTGTGGATCCTCTACGCCGGACGCATCGTGGCCGGCATCACCGGCGCCAC

AGGTGCGGTTGCTGGCGCCTATATCGCCGACATCACCGATGGGGAAGATCGGGCCCGCCACTTCGGGCTCATGAGCG

CTTGTTTCGGCGTGGGCATGGTGGCAGGCCCCGTGGCCGGGGGACTGTTGGGCGCCATCTCCTTGCATGCACCATTC

CTTGCGGCGGCGGTGCTCAACGGCCTCAACCTACTACTGGGCTGCTTCCTAATGCAGGAGTCGCATAAGGGAGAGCG

TCGACCGATGCCCTTGAGAGCCTTCAACCCAGTCAGCTCCTTCCGGTGGGCGCGGGGCATGGCTATCGTCGCCGCAC

TTATGACTGTGTTTCTTTATCATGC<u>AA</u>ACTCGTAGGGACAGGTGCCCGGCAGCG<u>CC</u>TCTGGGGTCATTTTTCGGCGA

A

4 pts.

2) What is the molecular weight of this unknown band? To get credit for this answer, you **must** show your work drawn by hand on the graph paper provided here. Limit your answer to a number and no words.
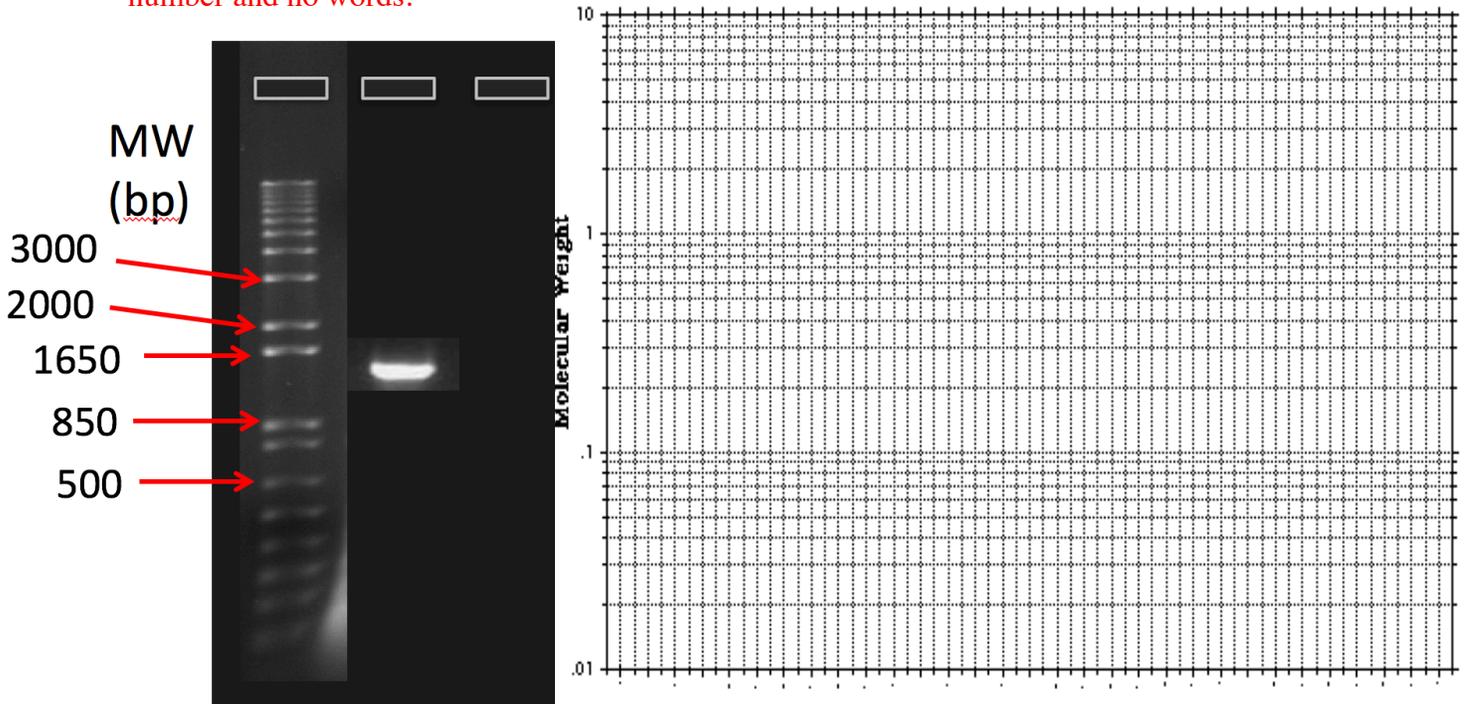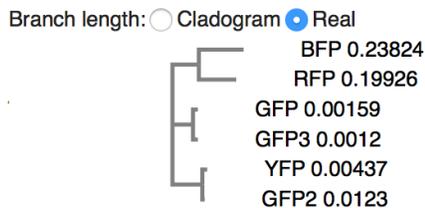

Answer: __varies, depending on correct graph____

Lecture Questions:

10 pts.

3) Go to the MUSCLE web site (http://www.ebi.ac.uk/Tools/msa/muscle/) and generate an evolutionary tree using the sequences found in the attached file called: FP_Sequences.docx Which gene is the most **dissimilar** to the one called GFP? Support your answer with a screen shot of your data.

screenshot here: BFP

20 pts.

4) Hopefully, your heart is not racing and your blood glucose levels are normal because you are well prepared for this exam.

a) Protein kinase A (PKA) requires what type of modulation in order to become activated? Support your answer with data. *Answer Limit: 40 words.*

allosteric, 2 cAMP molecules, #17

b) Which amino acid does PKA phosphorylate? Support your answer with two different figure numbers from the Data Gallery. (The second figure is indirect evidence.) *Answer Limit: 50 words*.

serine: #35 for direct evidence and #34 for –OH for phosphate addition

c) Figure 31 shows the activation of phosphorylase kinase. Explain what is required to fully activate phosphorylase kinase. *Answer Limit: 50 words*.

beta gets 1 phosphate quickly, alpha gets two phosphates over longer time, gamma activity mirrors phosphorylation of beta and alpha.

10 pts.

5) We eukaryotes like to think of ourselves as superior to other domains of life.

a) *E. coli* does not produce orthologs of human transcription factors. Would you expect to find human orthologs in prokaryotes that live in hot springs such as those found in Yellow Stone National Park? Support your answer with data. *Answer Limit: 40 words*.

yes, Archaea, #21

b) Draw a circle around the bootstrap value on this evolutionary tree that denotes the most recent common ancestor of mitochondria and a bacterial species alive today.
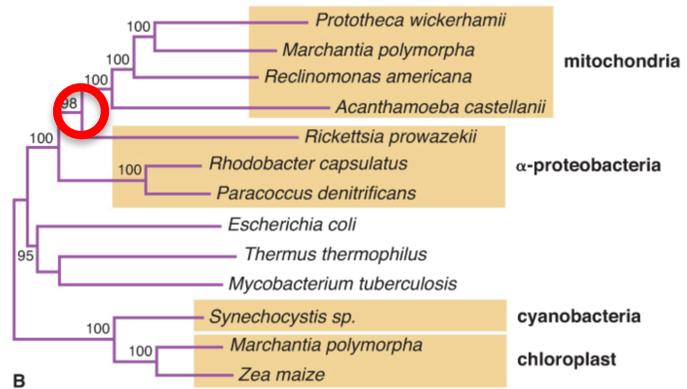
18 pts.

6) Here are some questions that blend lecture and lab.

a) List four molecular components that PCR and S phase of the cell cycle have in common. *Answer Limit: 10 words per component*.

1. primer (3' OH)
2. template
3. nucleotides (dNTPs)
4. DNA polymerase

b) Give me two cautionary lessons inherent in Figure 13 of the Data Gallery. One lesson should be based on a person's TAS2R38 genotype from lab, and the other should be about public health and the Clean Water Act policy in America. *Answer Limit: 40 words per lesson*.

1. PCR DNA polymerase can make mistakes so genotype may be erroneous
2. heavy metals from batteries can lead to mutations (dispose properly)

12 pts.

7) All species must have a way to reproduce.

a) Give two different examples of whole genome duplication. One example led to speciation but the other example did not. *Answer Limit: 30 words per example.*

#6: cancer polyploidy, not speciation

#19 or #3: invertebrates gave rise to vertebrates

b) Approximately how long does whole genome duplication take to happen? Support your answer by referring to information in the textbook. *Answer Limit: 40 words.*

one cell cycle (a few hours)

20 pts.

8) The origin of life is one of the most difficult topics for non-scientists to understand.

a) How could biologically important organic molecules be produced on a planet devoid of life? Give two documented mechanisms for their formation and support one of these two with data. *Answer Limit: 40 words per example.*

#1: lightening and Miller's experiment; UV light on comments

b) Which one type of molecule can be an enzyme, a genome and an osmotic stressor? Support your answer with two figures from the data gallery. *Answer Limit: 30 words per example.*

RNA: #5 ribozyme; #9 stressor

c) Use math-logic and two mechanisms of evolution to explain how diverse species arose on Earth after the first living cell evolved from an abiotic world. Support each answer with different data. *Answer Limit: 30 words each.*

math logic: vesicle growth doubles surface area, triples volume, spills content when divides, content stimulates new vesicle#5, 24/26
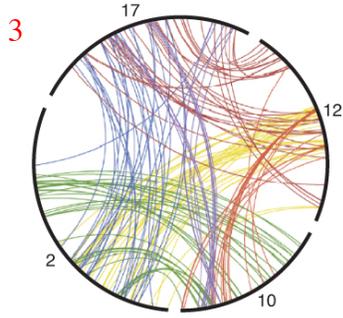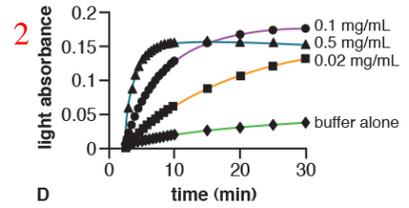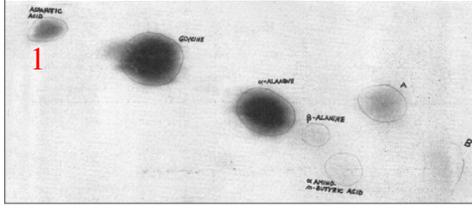
mechanism 1: mutation #13 or others

mechanism 2: natural selection #7, 33 or others

+2 pts

Bonus question: What evidence have you seen in lab that supports horizontal gene transfer has happened in the human genome? This is a tough question.
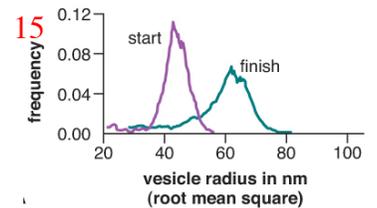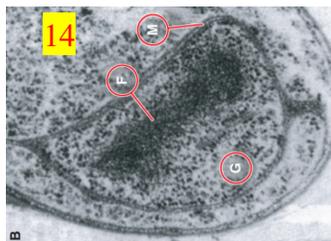
TAS2R38 does not have an intron like most human genes, may have reach us via retrovirus.
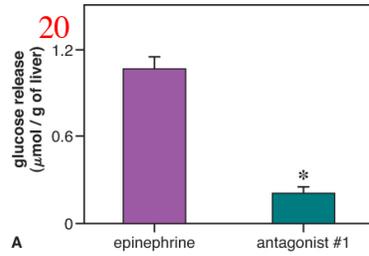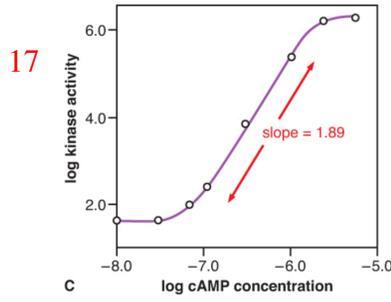
Data Gallery

vesicle
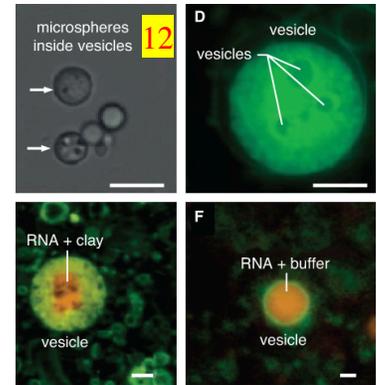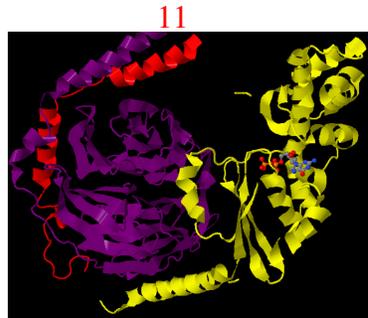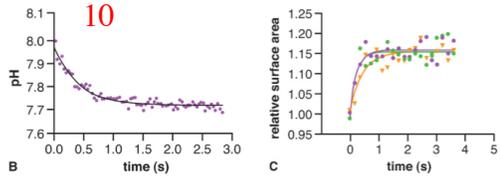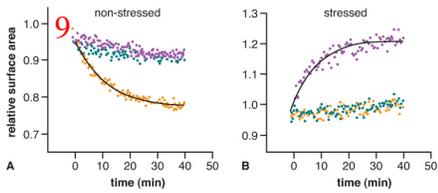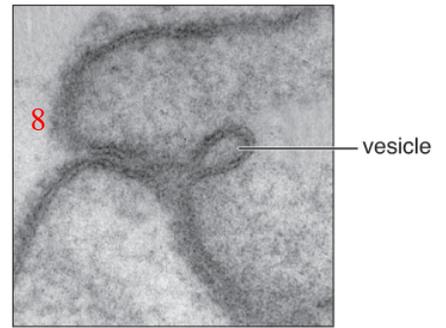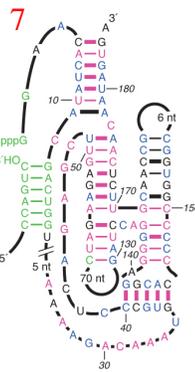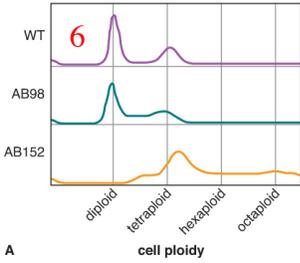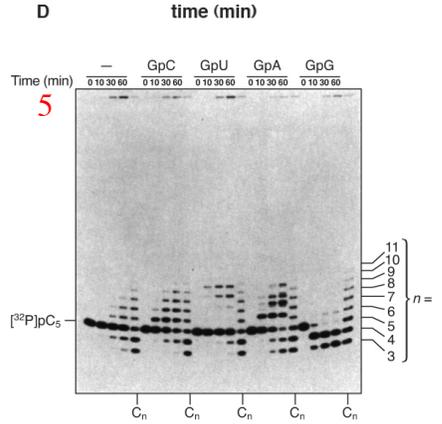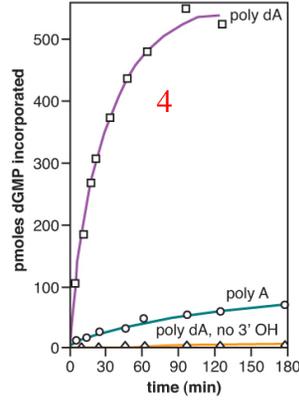
ions (concentration in mM)	error rate
Mg^{2+} (1.0)	1 in 41,000
Ni^{2+} (1.0)	1 in 5,030
Ni^{2+} (2.0)	1 in 1,850
Cd^{2+} (0.1)	1 in 7,810
Cd^{2+} (0.2)	1 in 5,070
Ca^{2+} (0.6)	1 in 7,520
Ca^{2+} (1.0)	1 in 5,500
Ca^{2+} (2.5)	1 in 3,760

13

16

17

slope = 1.89

18

19

20
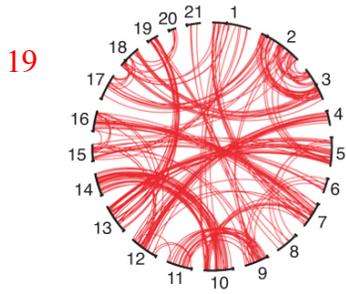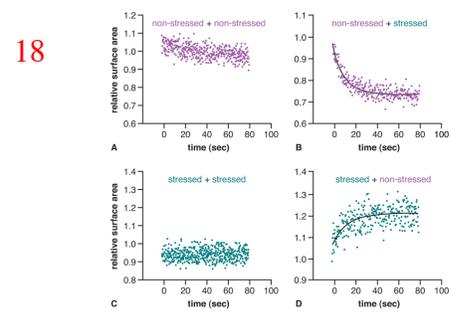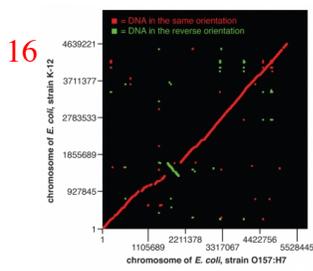
21

| human protein number	protein function	protein location	best match domain
NP_001009	translation	cytoplasm/rER	archaea
NP_003185.1	transcription factor	nucleus	archaea
NP_001001937	ATP synthase	mitochondria	bacteria
NP_005521	energy harvesting	mitochondria	bacteria
NP_000393	energy harvesting	cytoplasm	bacteria
NP_004138	cell signaling	cytoplasm	archaea
NP_061816	cytoskeleton	cytoplasm	bacteria

22

23

50 nm

24

25

26

27
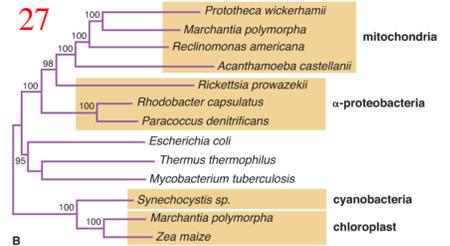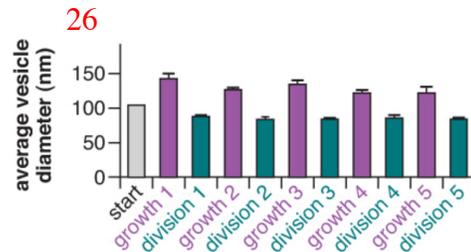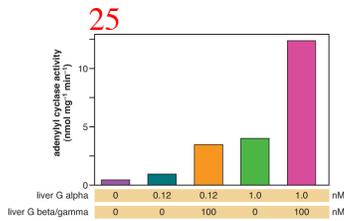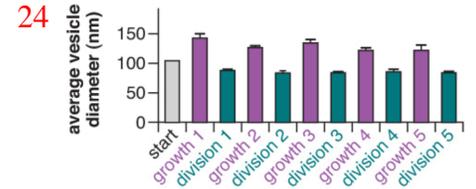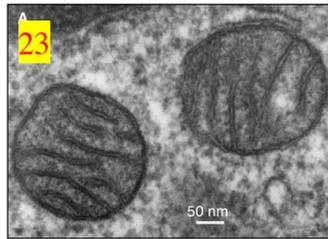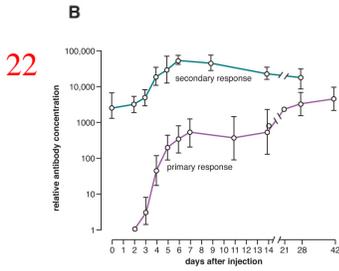
28

enzyme	liver	skeletal muscle
epinephrine receptor	✔	✔
G protein	✔	✔
adenylyl cyclase	✔	✔
protein kinase A	✔	✔
glycogen synthase	✔	✔
phosphorylase kinase	✔	✔
glycogen synthase	✔	✔

29

30

31

32

33

34
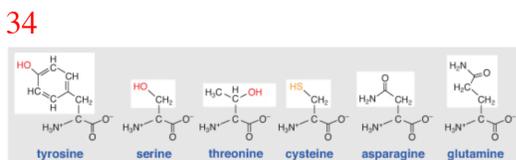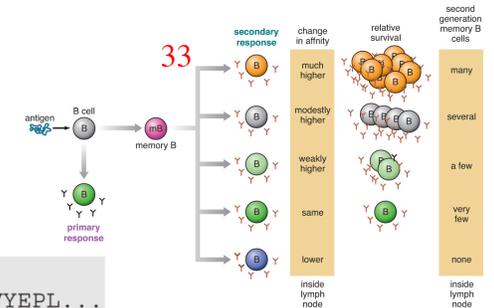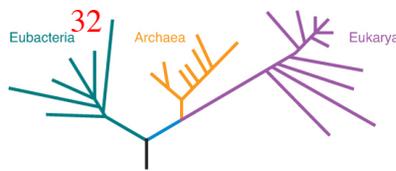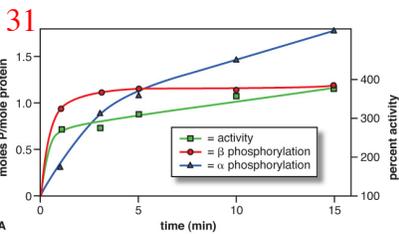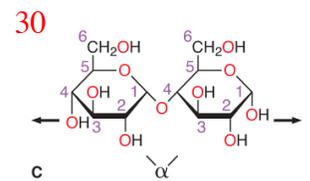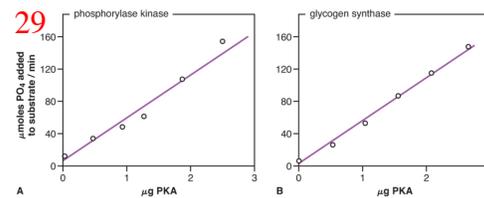
35

phosphorylase kinase

P
...KRSGSVYEPL...

glycogen synthase

P
...PRRASCTSSS...

7