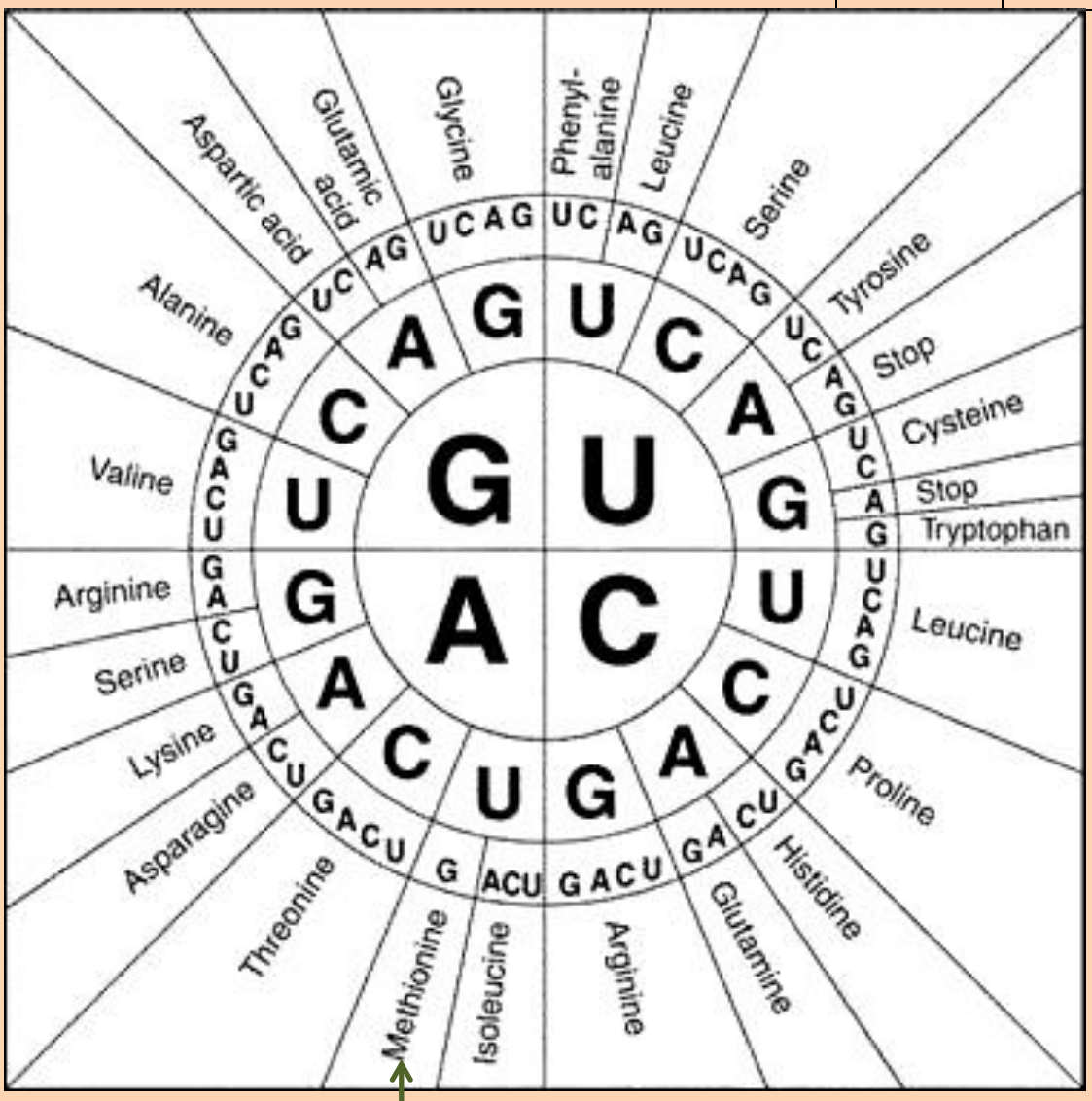
Biology 200, Winter 2018 *Name*: _____
Exam 2 *Student ID#:* _____ *TA*: _____ *Lab Section*: _____

DO NOT OPEN EXAM UNTIL DIRECTED TO DO SO

- Make sure you have 4 pages of questions and six pages total. Print your name and information on all pages.
- Please use a pen. Pen is much easier to read, even with extensive crossing-out. Pencil-written exams are acceptable, but may not receive full credit on regrade requests.
- When asked, provide concise and clearly written answers. We may deduct points if you do not fully answer the question or if your answer is too vague or too confusing for us to follow.
- Extra information, if incorrect, will lose points.
- Limit your answers to the space provided. If you need extra space, use the bottom of the last page. Indicate "on last page" where necessary.

Page	Points Awarded
2	_____ out of 19 points
3	_____ out of 20 points
4	_____ out of 21 points
5	_____ out of 20 points
Total	_____ out of 80 points

Codon Table:



Note: The most common start codon is Methionine.

/11 1) *Analyze the three mutated sequences below, and then place them in likely order of Most to Least functional protein produced. Changes from wildtype have been bolded/underlined where possible for clarity.*

The entire wildtype mRNA sequence:

5′–CCGUGAUGCCAGUCAGCAGCUCGGUGAAAUGACUUCCCUAUC–3′

Sequence D:

5′–CCGUGAUGC**AAC**UCAGCAGCUCGGUGAAAUGACUUCCCUA**G**C–3′

Sequence E:

5′–CC**GG**GUGAUGCCAGUCAGCAGCUCGGUGAAAUGACUUCCCUAUC–3′

Sequence F:

5′–CCGUGAUGCCAGUCAGCAGCU**GA**GUGAAAUGACUUCCCUAUC–3′

Most likely protein to be functional like the wildtype: ___

Least likely protein to be functional like the wildtype: ___

Explain your reasoning for your choice of most functional protein in 2-3 sentences, maximum. For full points, you should directly compare it to the other versions.

/8 2) Imagine a very small single-celled organism whose nucleus contains exactly one copy of each protein needed for DNA replication. This nucleus also contains 2 relatively small, linear chromosomes that each have 2 origins of replication. If the single copy of topoisomerase was destroyed, what will be the fate of the cell?

Describe what will happen to DNA replication and why in 2-3 sentences, max.

For questions 3a-d, mutations impact transcription in a prokaryotic organism. Combine what you know about mutations and what you know about transcription to answer each question.

/5 3a) Within the termination sequence of Gene Z, the sequence of the coding strand in the DNA was 5'CGACAGTCG3' but has been changed to the sequence 5'CGACAGAAA3'. What is the likely impact on transcription of this gene, and why? *Explain in 1-2 sentences, max.*

/5 3b) Gene G and Gene H are positioned such that there is a single change that is in both the promoter for Gene G and the coding region of Gene H. That change is from `5'ACTT3'` to `5'GCTG3'`.
Experiments indicate that this mutation has no impact on the function of any products of Gene G or Gene H. How is this possible?
Explain in 1-2 sentences, max.

`3'TGAA5'` to `3'CGAC5'`

/5 3c) A deletion of 6 codons in the coding region of the gene encoding the sigma protein causes a change in the protein such that it no longer has a DNA-binding region. What impact will this have on the transcription of genes in this organism? *Explain why in 1-2 sentences, max.*

/5 3d) Order the following in likely order from most to least total transcription in the cell.

A: The 1407-codon gene that encodes RNA polymerase has a one-basepair deletion in the 32nd codon.

B: Gene X has a single basepair change mutation 22 bases upstream of the +1.

C: An insertion into a gene of 3′-TGA-5′ happens in the middle of the coding region of Gene Y.

D: Change from 5′-CGA-3′ to 5′-TGA-3′ in 12th codon of the 1407-codon gene for RNA polymerase.

Examples : A > B > C > D or if you think B and C are equal then A > B = C > D

/10 4) Below is a portion of double stranded DNA from a bacterial chromosome.
The promoter region and the +1 base pair are indicated, as well as the polarity of the two DNA strands.

```
                                    -35      -10   +1
...5'..AGGCATGCCTTTTACCATGTAACTGGTATACTCGGATACTAATCATGCCGACGTGAGTA..3'....
...3'..TCCGTACGGAAAATGGTACATTGACCATATGAGCCTATGATTAGTACGGCTGCACTCAT..5'....
```

Using the codon table on Page 1, translate the protein sequence from this gene. Be sure to include the N- and C-termini. You can abbreviate amino acids using the 3-letter code, but you don't have to.

5a-b: Given its central importance to life on earth, you can imagine that scientists would be interested in developing an artificial replacement for the ribosome as a necessary element of creating artificial life. Answer these two hypothetical questions about the development of a ribosome-like replacement machine.

/5 5a) Imagine that scientists have achieved a breakthrough: Their artificial molecule is able to successfully recognize a start codon and polymerize any amino acids together. In their attempts to build a perfect ribosome replacement, what else do the scientists still need to develop in their molecule? *Explain in 1-2 sentences or a short, clear list.*

/6 5b) Imagine that the scientists were able to make a ribosome-like replacement that could stop polymerizing at the stop codon but which was not able to break a bond between tRNA and amino acid. *Create a diagram using images and a few words that makes clear what would happen and what would be the product(s) of this artificial ribosome.*

Use the diagram on Page 6 to answer Questions 6a-d as best you can. This hypothetical organism and set of questions is intended to test what you've learned in Bio200 in a new and challenging way. The explicit answers are not in any textbook, as this is a hypothetical organism meant to challenge your conceptual understanding.

/6 6a) Cell B has no ribosomes, but it does have some proteins. The structure of those proteins matches what you would expect from the genotype in Cell B. How is this possible? *Explain as completely as you can in 2-3 sentences.*

/5 6b) The  and  transporters can both transport a wide variety of proteins. However, they are very different in that  uses much more ATP to transport proteins than does  . How is protein moved into Cell A, and how is the ATP being used?

The  transporter is using *(circle one)*: Passive diffusion Facilitated diffusion Active Transport

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/5 6c) You do a few more experiments, and you find that at least in some individuals of this species that the transporter shown as  is able to move ribosomal subunits between Cells A/D and B/C. Do you think this transporter would have the same ability to move this molecule if additional bonds were added to hold the transporter in a very consistent, unchangeable structure.
Explain why or why not in 1-2 sentences, max.

/4 6d) This organism cannot survive if it has less than 16 types of amino-acyl tRNA synthetases enzymes. *Explain why in 1-2 sentences.*

This diagram is relevant to questions 6a-d.

Shown below is a complete organism with an unusual cellular architecture. This species has four cells and an internal enclosed space ('Cell' E) that is completely enclosed and acts like a fifth cell. Each cell is separated from the outside world and from other cells by a single lipid bilayer. For the purposes of this question, you can assume that molecules that would normally pass through a bilayer very slowly do not get through rapidly enough to help the organism survive (in other words, the organism uses some other mechanism besides passive diffusion of very impermeable molecules).

A few important items to note:
Cells A and B contain no ribosomes, but they do contain proteins, RNA and DNA.
Cells C and D contain no RNA polymerase, but they do contain ribosomes, proteins and DNA.
'Cell' E contains no DNA, ribosomes, or RNA but does contain proteins.

All three types of transport proteins in this organism are shown (as  or  or ).