

## DNA and Protein Synthesis Lab one

### Activity 1: Building Insulin

A. Replication: Using the DNA base pairing rules, determine the template DNA strand.

B. Transcription: Using the mRNA to DNA base pairing rules, determine the mRNA strand that would be made from this template DNA. (Assume there are no introns that will be removed)

C. Translation of the mRNA:

1. Determine the amino acid sequence using the table to make your team's part of the insulin protein chain.
2. Determine the tRNA anti-codons that would be used to bring the amino acids needed to build insulin to the ribosome.
3. Build your part of the insulin chain using the amino acids provided.

\*Note: This is not the only sequence for insulin. Uniprot provides full sequencing information on insulin and known variants. <http://www.uniprot.org/uniprot/P01308>

non-template DNA	template DNA	mRNA	amino acid	tRNA
a	t	a	AUG Met	u
t	a	u		a
g	c	g		c
g	c	g	GGG Gly	c
g	c	g		c
g	c	g		c
a	t	a	AUC Le	u
t	a	u		a
c	g	c		g
g	c	g	GUU Val	c
t	a	u		a
t	a	u		a

g	c	g	GAA Glu	u
a	t	a		u
a	t	a		g
c	g	c	CAA Gln	u
a	t	a		u
a	t	a		a
t	a	u	UGU Cys	c
g	c	g		a
t	a	c		a
t	a	g	GCC Ala	c
g	c	c		g
c	g	c		c
g	c	u	UCA Ser	g
c	g	c		g
c	g	a		a
t	a	g	GUU Val	g
c	g	u		u
a	t	u		c
g	c	g	UGU Cys	a
t	a	u		a
t	a	u		a
t	a	g	AGU Ser	c
g	c	u		a
t	a	a		u

a	t	a	AUA Ile	c
g	c	g		a
t	a	u		u
a	t	a	UAU Tyr	a
t	a	u		u
a	t	a		a
t	a	u	CAG Gln	g
a	t	a		u
t	a	u		c
c	g	g	CUU Leu	g
a	t	a		a
g	c	g		a
c	g	c	GAU Asp	c
t	a	u		u
t	a	u		a
g	c	g	AUA Ile	u
a	t	a		a
g	c	g		u

Answer the following questions:

1. Find and circle on your worksheet:
  - a. 2 locations where a single amino acid was coded by 2 different DNA/mRNA sequences.
    - i. What is the term for the fact that there may be more than one codon for a given amino acid? Why is this “ability” valuable?
  - b. Find a group with a start codon. What is the mRNA sequence? The mRNA sequence is AUG.

- c. Did your team use all the amino acids in the amino acid pool? The amino acids were used.

### Activity 2

Deeper thoughts on genetics codes

- Write the answers to the following questions in your lab notebook.
1. Copy the partial template HUMAN DNA sequence and template COW DNA sequence below into your lab notebook (leave room as shown to transcribe and translate the DNA).

HUMAN	A	T	A	T	G	G	G	G	C	T	T	T	C	G	T	A	T	C
mRNA																		
CODONS																		
COW	A	T	A	T	G	A	G	G	C	T	T	A	G	T	T	A	T	C
mRNA																		
CODONS																		

- a. Compare the template DNA Sequences and circle IN RED any single base that is different in the cow sequence.
  - i. How many bases are different? 4 Bases are different
- b. Using the transcription rules convert the template DNA to mRNA. Compare the codons and circle in BLUE any codons that are different in the cow sequence.
  - i. How many codons are different? Two codons are different.
- c. Use the codon table to translate the mRNA into amino acids. Examine the amino acids produced. Circle in YELLOW any amino acids that are different in the cow sequence.
  - i. How many different amino acids are there? 3
- d. Compare the transcription and translation differences – are there an equal number of unique codons and amino acids and unique amino acids in the cow sequence?
  - i. Why not? The second part of the codon is different because the first codon has some similarities.
- e. Could two humans (or two cows) have some differences in their DNA sequences for insulin, yet still make the exact same insulin proteins? Explain. Yes, depending on how the gene mutation occurs, differences may occur but as long as the same amino acids are translated it is fine.
- f. Examine the codon chart and list all of the codons that code for the amino acid arginine (arg). List them: CGU,CGC,CGA,CGC, AGA, AGG
- g. What do we call the phenomenon above (the presence of more than one possible codon for the same amino acid)? We would call the phenomenon a redundancy of genetic code.

### Activity 3

Diabetes is a disease characterized by the inability to break down sugars due to an alteration in the DNA sequence (and therefore the protein/enzyme used to signal cells to build the doorways to uptake proteins). When the amino acid in a sequence has been changed, the shape of the protein changes and can become less functional (or not function at all.)

- a. Record the DNA sequence for this portion of the insulin gene in your lab notebook. Transcribe and translate.

HUMAN	A	T	A	T	G	G	G	G	C	T	T	T	C	G	T	A	T	C
-------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

- b. Suppose a person has a mutation in their DNA, and the first triplet for the gene coding for insulin is ATT instead of ATA.
  - a. Transcribe and translate the new triplet (you don't need to repeat the rest).
  - b. Using the terms you reviewed earlier – what kind of mutation is this? This is considered a base mutation.
  - c. Will this person be diabetic? Explain. The person won't be because a base mutation doesn't change anything.
- c. Suppose a person has a mutation in their DNA, and the third triplet for the gene coding for insulin is GGA instead of GGC.
  - a. Transcribe and translate the new triplet (you don't need to repeat the rest).
  - b. Using the terms you reviewed earlier – what kind of mutation is this? This is a base mutation.
  - c. Will this person be diabetic? Explain. Nothing changes because it is a base mutation.
- d. Suppose an extra adenine is added after the 10<sup>th</sup> base in the DNA sequence when it is being replicated.
  - a. During what phase of the cell cycle did this occur?
  - b. Transcribe and translate the new sequence from the 4<sup>th</sup> triplet on.
  - c. Using the terms you reviewed earlier – what kind of mutation is this?
  - d. Will this person be diabetic? Explain.
- e. Suppose there is an inversion of bases 7 through 15.
  - a. Write the COMPLETE new sequence
  - b. Transcribe and translate the new sequence.
  - c. How many amino acids did the inversion effect? I affected all the end ones,
    - i. Is this more or less than you expected? I thought it would be similar to what had happened.
  - d. Using the terms you reviewed earlier – what kind of mutation is this? Inversion Mutation.

- e. Will this person be diabetic? Explain. It has a long inversion which led to the changes being confusing.

#### **Activity 4**

1. Make a concept map to show the relationship between the following terms.
  - a. Amino acids
  - b. Anticodons
  - c. Codons
  - d. DNA
  - e. mRNA
  - f. proteins
  - g. transcription
  - h. translation
  - i. tRNA
2. Explain why some mutations are more harmful than others.  
Some mutations can be more harmful than others based on how severe the amino acids are.
3. Explain the levels of bonding that determine protein shape. Why does a change in the amino acid sequence affect the shape (and therefore function) of a protein? The formation of amino acids comes together to shape the protein because it is essential to its function.