Activity 2.2.2
A Protein Problem

From four letters to a working protein. Transcription, translation, the codon table and the reading frame. Today you run the process correctly. Tomorrow you break it on purpose.

DATE	PORTAL DAY	LESSON	TURN IN
Wednesday 2026-10-26	**DNA and protein modeling**	**Lesson 2.2 Decoding a Diagnosis**	**Lab report**

Where this sits. Day 1 of 2. Portal calendar label for today: DNA and protein modeling.

01 Why today matters

Your patient's condition, whatever it turns out to be called, comes down to one protein that is not doing its job.

Before you can explain that to his parents you have to be able to run the process yourself, from a strand of DNA to a chain of amino acids, without shortcuts.

02 What you already know

- You know DNA lives in the nucleus, that it is made of four bases, and that it gets copied before a cell divides.
- From yesterday you know a protein can control how fast cells divide. Today you find out how a sequence of four letters turns into a molecule that does a job.

WHAT THIS SHEET WILL NOT TELL YOU

- This sheet names no diagnosis and no gene. It teaches the process. What your patient's report says is tomorrow's work.

03 Vocabulary

TERM	WHAT IT MEANS, PLAINLY
Gene	A stretch of DNA that carries the instructions for one protein.
Genetic disorder	A health condition caused by a change in the DNA sequence of one or more genes.
Mutation	Any change to a DNA sequence. Common, usually harmless, occasionally decisive.
Nucleotide	One unit of DNA or RNA. In DNA the four are A, T, C and G. In RNA, U replaces T.
RNA	The other nucleic acid. Single stranded, built on a different sugar, and it uses U where DNA uses T.
Messenger RNA (mRNA)	The working copy of a gene, carried out of the nucleus to where proteins get built.
Transcription	Copying a gene from DNA into mRNA. It happens inside the nucleus.
RNA polymerase	The enzyme that reads the DNA and builds the mRNA copy.

Translation	Reading the mRNA three letters at a time and assembling the matching chain of amino acids.
Ribosome	The organelle that does the reading. It moves along the mRNA and holds the growing chain.
Transfer RNA (tRNA)	The delivery molecule. Each one carries one amino acid to the ribosome and matches it to the right three-letter code.
Codon	Three consecutive mRNA bases. One codon specifies exactly one amino acid, though one amino acid may have several codons.
Start codon	AUG. Where the ribosome begins, and it also sets where every following group of three begins. The first amino acid in a human protein is always methionine because of it.
Stop codon	One of three codons that specify no amino acid at all. The ribosome reads one and lets go.
Reading frame	Which grouping of three the ribosome is using. Set by the start codon. Shift it by one letter and every codon after that point is a different codon.
Amino acid	One link of a protein chain. Twenty of them, in the order the gene specified.
Protein	A chain of amino acids folded into a shape. The order sets the shape and the shape sets the job.
Enzyme	A protein that drives a chemical reaction. One of the six protein jobs you will list today.
DNA sequencing	Reading the actual order of bases in a stretch of DNA.
Bioinformatics	Software that compares and analyses DNA sequences. Necessary once a gene runs to thousands of bases.

Every term on this list is flagged for the illustrated glossary, scoped to this activity only. Terms are not shared forward or backward between activities, because a definition from a later activity can hand you an answer you were supposed to derive.

04 How to do the work

This is a modeling lab. Every strand gets a label and a color, and every step of the conversion stays on the page.

1. List the six jobs proteins do: driving reactions, defense, building structures, transporting materials, coordinating cell activities, and movement. Give one named example for each.
2. Read the description of the protein your patient's gene is responsible for, and decide which of the six jobs it belongs to. Write your reasoning, not just your choice.
3. Build the DNA and RNA comparison table: number of strands, which sugar, which four bases, and the pairing rules. Note the one difference that changes everything downstream.
4. Watch the protein synthesis sequence, then complete the ordered set of statements in your notebook: where DNA is kept, what starts transcription, where transcription happens, which enzyme reads the DNA, where the mRNA travels, what reads it there, what tRNA delivers, and what the finished chain becomes.
5. Write out the practice DNA sequence from the activity across your page with plenty of space above it. Label it DNA.
6. Transcribe it. Write the mRNA directly above or below in your second color and label it mRNA. Check the pairing rule at every base: in RNA, A pairs with U, not with T.
7. Find the first AUG reading left to right. Mark it. This is where translation starts and it sets the frame.
8. From that AUG, draw a bracket under every group of three all the way along. Do this before you look up a single codon. Once the frame is drawn, the lookups cannot drift.
9. Practice on four codons first: AUG, CCC, UAC and GAU. Use the circular chart, reading from the center outward: first base in the middle, second base in the next ring, third base in the outer ring. Check your four answers against the activity before you go further.

10 Translate your bracketed sequence codon by codon. Stop at the first stop codon in that frame. Write the amino acid chain in order underneath the mRNA.

11 Read the worked single-base example in the activity that shows one changed base producing one changed amino acid. Note how small the change is and how large the consequence.

12 Write the summary paragraph: how a sequence of four letters ends up as a molecule with a job, in language a parent could follow.

MATERIALS

- Lab notebook
- Two colors of pen or pencil, one for DNA and one for RNA
- The codon chart from the activity, the circular one
- A ruler or a straight edge for keeping codons grouped

CHECK THE CODON CHART YOU ARE USING

- Use the circular chart image, read from the center outward. If you are working from the plain text list that accompanies it as an image description, check it against the wheel before you trust a lookup.
- That text list contains at least three rows where a codon has been printed under the wrong amino acid, and one row where a codon is missing. It is an accessibility transcription, and it has errors in it.
- This is a good habit in general and not a complaint about one document: when two versions of a reference disagree, find out which one is the original before you build an answer on either.
- If you find a disagreement, write it down and tell your teacher. Catching an error in a published reference is a real result.

05 Where students get stuck

- Writing T in the mRNA. RNA has no T. Every A in the DNA template pairs with U. This single slip produces an mRNA that cannot be looked up, and students usually discover it four codons later.
- Reading the circular chart from the outside in. The center ring is the first base, the middle ring the second, the outer ring the third. Read it the other way and you get a real amino acid every time, which is why the error survives to the end of the sequence.
- Starting translation at the first base instead of the first AUG. The frame is set by the start codon. Any translation that begins before it is grouping the wrong letters together and every amino acid after that is wrong.
- Grouping codons after looking them up rather than before. Bracket every group of three across the whole sequence first, then look up. If you look up as you go, one skipped letter shifts everything after it and there is nothing on the page to catch it.
- Getting the many-to-one relationship backwards. Several different codons can specify the same amino acid. One codon never specifies more than one amino acid. Reverse that and the whole system stops making sense.
- Reading past the stop codon. A stop codon codes for no amino acid. The chain ends there. Adding an amino acid for it is a common and easy error to spot in your own work if you look for it.

06 What you turn in

LAB REPORT

A lab report with these sections. Purpose: what you were modeling and why it matters for this patient. Method: how you transcribed and translated, including how you set and marked the reading frame. Results: the original DNA strand, the mRNA strand, both labeled and in different colors, the marked start codon, the bracketed codons and the amino acid chain in order. Discussion: your six protein jobs table with the assignment you made for the patient's protein and your reasoning, plus the parent-facing summary paragraph. Sources of error: name any place your sequence had to be redone and what caused it. If you found a disagreement between the two versions of the codon chart, record it here.

07 Check yourself

- [ ] A DNA strand reads TAC. What is the mRNA codon, and what one rule did you have to apply that you would not need for DNA to DNA? (Vocabulary, RNA, and Where students get stuck)
- [ ] Why does the position of the first AUG matter more than the position of any other codon in the sequence? (Vocabulary, reading frame)
- [ ] One amino acid can be specified by four different codons. Can one codon specify four different amino acids? Explain why the two situations are not symmetric. (Vocabulary, codon)