

PART III. PROTEIN SYNTHESIS SATISFIES: How DNA Makes It

A. PREPARATION

1. Read the section in your text that explains how DNA directs protein synthesis.
2. Cut out all of the pieces on the three attached cutout pages (keep the pieces in an envelope when not in use).
3. SET UP: Place the "Nuclear Membrane" strip vertically on the middle of your desk. Take the original (white) DNA molecule used in the REPLICATION kit, and place it to the right of the "membrane", along with all the blue mRNA (messenger-RNA) nucleotides scattered next to it. This represents the contents of the nucleus.
4. Now, on the left side of the membrane (in the "cytoplasm"), place the "ribosome" surface in a horizontal position across the bottom of that area, and scatter the yellow tRNA (transfer-RNA) pieces and the green amino acids around in the area above the ribosome surface.

B. THE PROCESS OF PROTEIN SYNTHESIS: Think of protein synthesis as a construction process, in which the finished product is a particular protein (perhaps an enzyme), and it was assembled according to the directions from the "Master Plans" (DNA) in the nucleus.

1. FIRST, blueprint copies of the building plans must be made from the Master Plans (DNA) in the nucleus, and sent out to the construction site (ribosomes in the cytoplasm):
 - a. The DNA "unzips", separating the two DNA strands. Set aside the left strand, and use only the right strand for the next step.
 - b. Move the blue mRNA nucleotides, one at a time, to positions where their base-ends fit the exposed DNA base-ends, starting at one end of the DNA and working toward the other end: A to T, U to A, etc. There will be some unused nucleotides left over in the "nucleotide pool"; that's ok.
 - c. The chain of mRNA nucleotides (blue) would now be attached to each other, in a sequence which matches (in a complementary way) the original DNA sequence. You could paste, glue, or tape the mRNA nucleotides together, but for now, just hold them in position with your fingers, and move them away from the DNA, "through" (under) the "nuclear membrane", and over onto the ribosome surface, with their base ends exposed upward. The mRNA serves as a "blueprint" copy of the DNA message (gene), and carries that message out of the nucleus and into the cytoplasm, where ribosomes help to assemble a chain of amino acids into a sequence dictated by that message.
2. NEXT, the Construction Supervisor (ribosome) reads the blueprints (mRNA) for the building (protein), and directs the assembly of all the building parts (amino acids) into their proper places to make the finished building (protein). (In this simplified version, think of the ribosome as the Supervisors' blueprint table, making it easier to read the blueprints).

Yellow "specialty" trucks (tRNA) have picked up their appropriate loads of concrete, bricks, lumber, glass, plumbing, etc. (green amino acids), and can bring them only to specific locations at the unloading dock, according to the supervisors' directions (sequence of nucleotide shapes in the mRNA "unloading dock"), so the 3-nucleotide sequence in the "bumper" of each tRNA truck must fit a 3-nucleotide sequence in the mRNA "unloading dock".

 - a. Fit each amino acid (green) into its matching tRNA (yellow)
 - b. Move the tRNA (with its amino acid load) which fits the first 3-nucleotide sequence in the mRNA ("UUU" at the left end), and position it so its nucleotide shapes are touching the mRNA nucleotide shapes.

- c. Move the next tRNA (with its load, too) which fits the NEXT 3-nucleotide sequence, and position it so that their matching nucleotide base ends touch, too.
- d. Finally, move the third tRNA and its amino acid load, and fit it into the last 3-nucleotide sequence of the mRNA.
- e. The three amino acids should be touching "head-to-tail" in such a way that they could be glued together, but for repeated practice, just pretend that they become attached to each other (remember "dehydration synthesis"?) by placing your finger tips on their connecting points, and moving the three amino acids away as a "polypeptide unit", representing a much reduced version of the final protein product. (The yellow tRNA molecules would move away and pick up new loads of amino acids, ready for the next assembly).
- f. If you have done this properly, the first letter of the name for each amino acid assembled here should spell out a simple 3-letter word. **DO NOT TELL ANY OTHER STUDENT WHAT THAT WORD IS.** Write it on a slip of paper, and show it secretly to your teacher. If it is correct, your teacher will do something exciting, and give you another, longer message to decode on paper, following the special instructions provided. This should be more fun than a barrel of ribosomes!
3. After a little practice, review the text material on protein synthesis. Also read about (a) variations and further details about the process, (b) the "one-gene - one-enzyme" concept, (c) the nature of mutations, (d) the relation of DNA to chromosomes, and (e) the work in recombinant DNA and genetic engineering.
4. All living things are built and controlled with this same DNA code! With all this new found knowledge, you should be able to build your own creature... or at least your own secret messages, written in the CODE OF LIFE. Try this, exchanging messages with your friends (or enemies). Use the "**Say It With DNA**" package, if provided.
5. **CHECK YOUR UNDERSTANDING BY MATCHING:** For each part or stage of Protein Synthesis listed in the center, indicate the letter for the correct matching component from the "construction analogy" on the left. For another check on your understanding, do the same thing with the "tape player analogy" on the right.

CONSTRUCTION ANALOGY		PROTEIN SYNTHESIS		TAPE PLAYER ANALOGY
A. BLUEPRINTS	___	NUCLEUS	___	I. MUSICAL NOTES
B. SUPERVISOR	___	DNA	___	J. TAPE PLAYER
C. TRUCKS	___	CYTOPLASM	___	K. TAPE COPY
D. FINISHED BUILDING	___	RIBOSOME	___	L. SONG
E. CONCRETE & LUMBER	___	mRNA	___	M. RECORDING STUDIO
F. MASTER PLANS	___	tRNA	___	N. ELECTRIC CURRENT
G. BUILDING SITE	___	AMINO ACIDS	___	O. MASTER TAPE
H. ARCHITECT'S OFFICE	___	PROTEIN	___	P. TAPE PLAYING HEAD