One Gene, Many Products

How evidence changed a model of gene expression

GEN.2A.5 "Enrichment: Evaluate Beadle and Tatum's "One Gene-One Enzyme Hypothesis" (1941) in the development of the central dogma (DNA →RNA →Protein). Explain how new discoveries, such as alternate splicing of introns..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the mold results that support the 1941 hypothesis, circle claims about how many products one gene can yield, and number the steps from DNA to protein in order.

A Hypothesis That Changed

1. In 1941, George Beadle and Edward Tatum studied the bread mold Neurospora. They exposed spores to radiation, then searched for mutant strains that could not grow on a simple nutrient mixture. Some mutants grew when a particular vitamin or amino acid was added. This rescue suggested that a chemical reaction in the mold's nutrient-making pathway had stopped. Because different mutations blocked different steps, the researchers proposed that each gene directs the production of one enzyme, a protein that speeds a reaction. Their one gene-one enzyme hypothesis turned an abstract question about genes into a testable connection between genes and cell chemistry.

2. The hypothesis helped scientists connect inherited instructions to molecules that do work. Later research showed that DNA stores genetic information, RNA carries a copied message, and ribosomes use messenger RNA to build a protein. This common route is written DNA → RNA → protein. Beadle and Tatum's work supported the link between genes and proteins, but it did not establish every step in this route. Their claim was also too narrow: many proteins, including some structural proteins, are not enzymes. A more useful starting point became "one gene-one polypeptide," since a polypeptide is a chain that can form all or part of a protein.

3. Even "one gene-one polypeptide" needs a qualification. In many eukaryotic genes, the first RNA transcript contains exons and introns. Cells remove introns, then join exons to make a mature messenger RNA. Through alternate splicing, a cell can join different combinations of exons from the same transcript. Those messages can direct the production of different polypeptides from one gene. The information still generally travels from DNA through RNA to protein, but one DNA sequence need not have just one protein product. This discovery revises the idea of a fixed one-to-one match between a gene and a protein, rather than erasing the entire route.

2 ANSWER WITH EVIDENCE

Use the passage

1. How did the mutant mold results support Beadle and Tatum's idea that genes affect specific chemical reactions?

2. Why did Beadle and Tatum's results support the DNA → RNA → protein route without establishing every step of it?

3. How do structural proteins show a limit of the one gene-one enzyme hypothesis?

4. How does alternate splicing change the predicted number of products from one gene, and what part of the DNA → RNA → protein route remains?

3 YOUR TURN

Your own words

Invent a gene with at least three labeled exons and give two different exon combinations used in its mature RNAs. In four sentences, explain how your model revises the 1941 hypothesis without discarding the DNA → RNA → protein route.

ANSWER KEY

One Gene, Many Products

HIGH SCHOOL · GEN.2A.5

PART 1 · READ AND MARK

Underline the mold results that support the 1941 hypothesis, circle claims about how many products one gene can yield, and number the steps from DNA to protein in order. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How did the mutant mold results support Beadle and Tatum's idea that genes affect specific chemical reactions?	**Different mutations blocked different steps in nutrient-making pathways. Adding a particular nutrient rescued some mutants, supporting a link between a gene and an enzyme needed for a reaction.**
2	Why did Beadle and Tatum's results support the DNA → RNA → protein route without establishing every step of it?	**Their results connected genes to the proteins involved in cell chemistry, but they did not show how RNA carries information from DNA to ribosomes.**
3	How do structural proteins show a limit of the one gene-one enzyme hypothesis?	**Structural proteins are proteins but not enzymes, so the claim that a gene directs an enzyme does not account for every protein product.**
4	How does alternate splicing change the predicted number of products from one gene, and what part of the DNA → RNA → protein route remains?	**Different exon combinations can produce different mature RNAs and polypeptides from one gene. Information still generally travels from DNA through RNA to protein.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My invented gene, Lumen, has exons A, B, C, and D. One mature RNA joins A, B, and D, while another joins A, C, and D, so the messages could make different polypeptides. That possibility challenges the 1941 claim that each gene directs one enzyme, since one gene can yield more than one protein product. In both cases, DNA is transcribed into RNA, which is processed before ribosomes use it to build a polypeptide.

For the open task, accept any invented gene with at least three labeled exons and two distinct exon combinations. The explanation should connect alternate splicing to possible different protein products while retaining the DNA-to-RNA-to-protein route.