

Student Explanations about Molecular Processes During Information Flow and Transfer in Biology

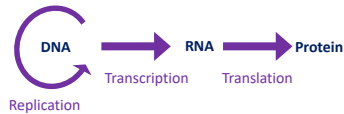
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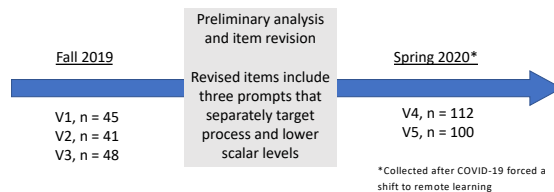
What types of explanations do undergraduates write about transcription?
What item characteristics more often elicit a mechanistic explanation about transcription?

Constructing Explanations



- Biology explanations are mechanistic (van Mil, 2013)
- Learning mechanisms can lead to longer retention (Todd & Romine, 2018)
- Non-mechanistic conceptions of genetic phenomena can be a barrier to learning (Haskal-Ittah & Yarden, 2018)

Data Collection



References

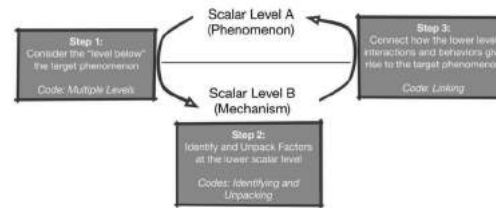
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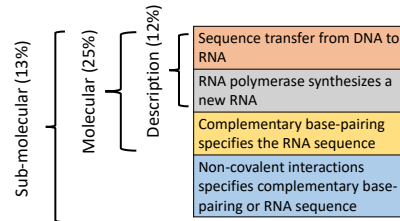
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Student Mechanistic Explanations Include Ideas Related to Gene Regulation

Theoretical Framework and Coding Rubric



Essential Epistemic Heuristics for Mechanistic Reasoning (EEHMR) Framework from Krist, et al, 2018



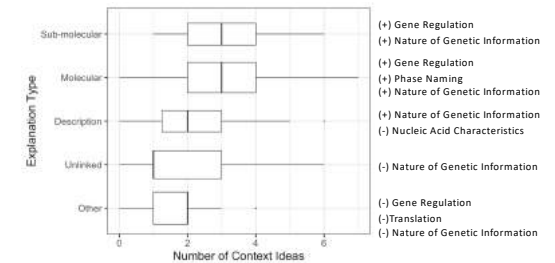
Remaining responses categorized as:

- Unlinked (21%)
- Other (29%)

Example Response

During transcription, RNA polymerase reads a strand of DNA from the 3' end to the 5' and links nucleotides that are complementary to the ones in the template strand from the 5' end to the 3' end. The nucleotides of DNA and RNA are arranged in a certain order according to one's genetics, allowing them to act as a blueprint for translating into sequences of amino acids and eventually proteins. The nucleotides are complementary to each other. A is paired with T in DNA or U in RNA. C is paired with G in both. The nucleotides are purines and pyrimidines linked together by hydrogen bonds which can be broken for DNA replication or transcription.

Codes: [Sequence Transfer](#), [RNA Polymerase](#), [Complementary Base-pairing](#), [Non-covalent Interactions](#).



Boxplot showing median number of context ideas by explanation type. Correlations between explanation types and ideas.

(+) positive significant Phi coefficient (-) negative significant Phi coefficient

Multi-part prompts targeting multiple scalar levels produce more mechanistic explanations

Example Prompt

- V5: During transcription, a **new strand of RNA is formed**, which holds the information from the DNA.
- Describe the process used to transfer this **information**.
 - Identify and **explain the characteristics of DNA and RNA** that allow it to hold information.
 - Identify and **explain the characteristics of nucleotides** that allow **transfer of information**.

Highlighted words indicate features different from other prompts (purple) or believed to support student mechanistic explanations (teal).

