

Helping Pre-Medical Students Learn about Multifactorial Genetics: The Answer Just Might be in the Question Design

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BACKGROUND

Historically, genetics education at the undergraduate level has centered predominantly on genes and patterns of inheritance (Schmid et al., 2022). While there are many examples of single gene genetics, most complex traits are best explained by **multifactorial genetics**, where many factors including a combination of genes, the environment, and gene-environment interactions play important roles. From an education standpoint, it has been shown that courses that focus more on single gene genetics rather than multifactorial may lead to students having deterministic thinking.

SIGNIFICANCE

It is important that aspiring and practicing physicians have a strong understanding of genetics. This understanding will help reduce **deterministic** thinking, as they navigate the complexities of genetic traits and diseases in diverse patient populations (Donovan et al., 2021)

RESEARCH QUESTION

To what extent do pre-medical students discuss multifactorial genetics concepts when working through medical scenarios and questions from MCAT test prep materials?

METHODS

- Participants: 12 undergraduate pre-medical students
- Two Khan academy MCAT practice prompts with developed questions.
 - Genes only prompt – Marfan’s Syndrome
 - Genes and environment prompt – Crohn’s Disease
 - Developed hypothetical scenario questions
- Participants interacted with the prompts and questions in a think-aloud interview format

STUDENTS WERE MORE LIKELY TO INCORPORATE MULTIFACTORIAL GENETICS WHEN EXPLAINING MEDICAL PROMPTS THAT INCLUDE THE ROLE OF THE ENVIRONMENT

Marfan Syndrome Student Response:

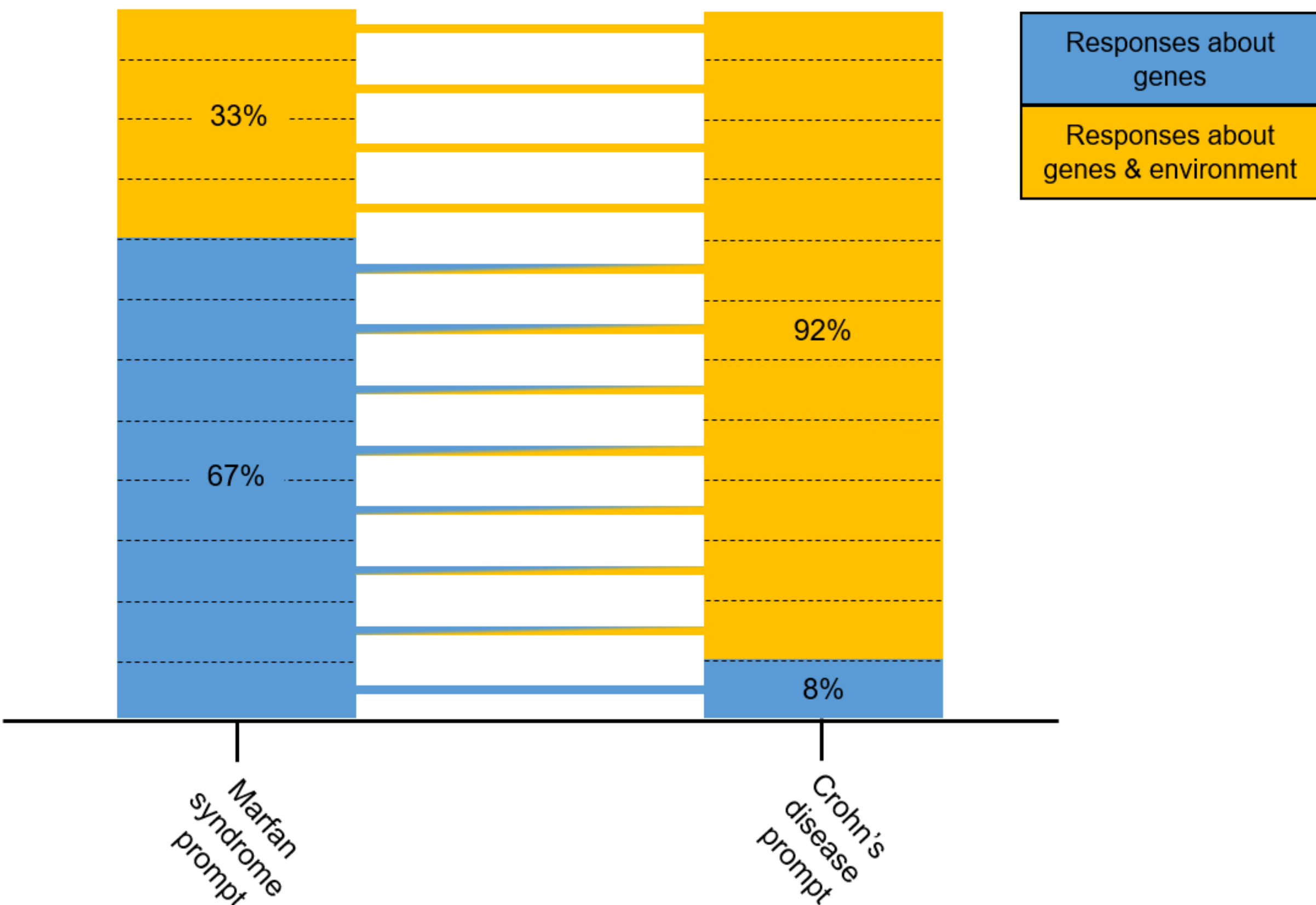
Will someone with a mutation on the FBN1 gene always have the same clinical presentation of Marfan syndrome? Explain your answer.

Example response that does not include the environment: “I would say yes. An explanation would be well, it says the FBN1 gene, the FBN1 protein is essential in creating extracellular matrix. And low levels of that protein can lead to elevated transforming growth factor beta, which leads to the degradation of the ECM.”

Crohn’s Disease Student Response:

Will someone with a mutation on the NOD2 gene always have the same clinical presentation of Crohn’s disease? Explain your answer.

Example response that includes the environment: “I feel like it’s a yes and no, because, like, the person’s like, innate immune system is gonna, like break down and it’s gonna result in chronic inflammation. But on the other hand, everybody’s like, immune system is different due to... due to their genetics and like, environment that they grew up in. So like, even though they might have chronic inflammation, they might have other side effects that will present itself that you won’t see from person to person.”



STUDENTS HAVE AN UNDERSTANDING OF THE ROLE OF GENES AND THE ENVIRONMENT BUT STRUGGLE WITH THE INTERACTION BETWEEN THEM

Hypothetical scenario question:

Consider this hypothetical scenario: Individual A has the wildtype NOD2 gene. When eating a regular or a high fiber diet, they do not have gastrointestinal inflammation. Individual B has a mutated version of the NOD2 gene. When eating a regular diet, Individual B has 2x gastrointestinal inflammation than baseline levels. When eating a high fiber diet, Individual B’s reduces to baseline levels. Which of the following explanations describes this scenario? Explain your answer.

- Which version of the NOD2 gene an individual has is the only influence on gastrointestinal inflammation.
- Diet only influences gastrointestinal inflammation.
- Which version of the NOD2 gene an individual has and diet influence gastrointestinal inflammation.
- Which version of the NOD2 gene an individual has impacts how they respond to different diets.**

	(A) Genes only	(B) Environment only	(C) G+E	(D) GxE
Genes Prompt about Marfan syndrome	0%	8%	67%	25%
Genes and Environment prompt about Crohn’s disease	0%	8%	59%	33%

TAKE AWAYS & FUTURE DIRECTIONS

- Unless explicitly mentioned, students are less likely to incorporate multifactorial genetics into their explanations of medical scenarios.
- The importance of genetics in medicine highlights the need for pre-medical and medical students to understand multifactorial genetics and engage with materials that include the role of the environment.

REFERENCES

Donovan, B. M., Weindling, M., Salazar, B., Duncan, A., Stuhlsatz, M., & Keck, P. (2021). *Journal of Research in Science Teaching*.
Schmid, K.M., Lee, D., Weindling, W., Syed, A., Agyemang, S.L.A., Donovan, B., Radick, G., Smith, M.K. (2022). Mendelian or Multifactorial? Current undergraduate genetics assessments focus on genes and rarely include the environment. *In review*.

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