Identifying the Most Common Student Misconceptions in General Microbiology

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Presentation Goals

• After this presentation, you should be able to:
  – Describe how student misconceptions in general microbiology were identified
  – Name the most common misconceptions found in this study
Identifying Student Misconceptions

• Early step in process of developing a concept inventory
  – Create a T/F question for a learning outcome (ours based on the ASM’s Curriculum Guidelines for Undergraduate Microbiology)
  – Ask students to answer the question AND explain their reasoning for the answer they chose
  – Review the student explanations and sort into “codes” of correct and incorrect explanations

• Codes are the basis for identifying misconception themes
Study Overview

• 743 student responses from 8 participating institutions
• Limitations: Only elicited student misconceptions to the particular outcomes and specific question topics that we gave to students. Other common misconceptions in microbiology may be left undetermined.
Most Common Misconceptions

• We defined any codes with at least 5% of the responses to be a “common misconception”

• Codes meeting the cutoff were evaluated and some were further condensed into broader “themes”, resulting in 19 total common misconception themes
Question

• Of the ASM Curriculum Guidelines’ Core Concepts, in which do you believe we found the misconception with the highest % of responses?
Most Common Misconceptions #1

• Core Concept – Evolution
• **T/F:** "A bacterium can acquire resistance to an antibiotic to which it has not been exposed."
• Misconception (43% of coded responses): *Change is intentional and in response to external conditions*
• Example response: “A bacterium must be first exposed to the antibiotic in order to be able to mutate and become resistant to the antibiotic."
Most Common Misconceptions #2

- Core Concept – Cell Structure/Function
- **T/F**: "In order to be effective, vaccines must cause an immune response to all characteristics of a pathogen."
- Misconception (21% of coded responses): *The entire, disease-causing pathogen must be present in a vaccine*
- Example response: "It must cause an immune response to all characteristics"
Most Common Misconceptions #3

- Core Concept – Metabolism
- **T/F:** "The strains of Lactobacilli used in cheese-making generate energy exclusively through fermentative pathways enabling them to grow at the same rate in the presence and absence of oxygen."
- Misconception (19% of coded responses): *Oxygen is required for bacterial growth and/or speeds up growth*
- Example response: "Fermentation requires oxygen"
Most Common Misconceptions #4

- Core Concept – Evolution
- **T/F**: "Genome sequencing of a microbial species might demonstrate genes originating from a variety of other species."
- Misconception (19% of coded responses): *Gene transfer is only vertical and from a common ancestor*
- Example response: "Everything came from one common ancestor, and then branched off into several subspecies."
Most Common Misconceptions #5

• Core Concept – Genetics

**T/F:** "An RNA-dependent RNA polymerase is required for replication of a DNA viral genome."

• Misconception (19% of coded responses): *Confusion about the role of RNA, RNA polymerase, and RNA primase in DNA replication and transcription*

• Example response: "RNA is not needed in DNA"
Other Common Misconceptions

• Common ancestry - *Genetics only type of evidence of common ancestry (not proteins or pathways, don't see link)*

• Cell structure – *Mitochondria/chloroplasts required for respiration/photosynthesis, so prokaryotic cells must have them*

• Antibiotics - *Antibiotics work the same in all prokaryotes (prokaryotes are all the same)*
Other Common Misconceptions

- **Immunity** - Body stores antibodies for future encounters
- **Mutations** - Mutations are always detrimental and always turn off gene expression
- **Central Dogma** - Gene expression is the same in all cells (so eukaryotic genes can be cloned directly into bacterial cell)
Microbial Systems/
Impact of Microorganisms

• No clear misconception themes emerged from these core concepts
• Student explanations were difficult to interpret, perhaps stemming from unfamiliarity with the scenarios given in the T/F statements.
Conclusions

- Identifying common student misconceptions in microbiology is useful knowledge for instructors
  - The Microbiology Concept Inventory distractors are based on these misconceptions, so you can use the MCI to gain insight into your students’ particular misconceptions
- Full results of the misconception analysis will be available (manuscript under review with *JMBE*)
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