IOWA STATE UNIVERSITY
Plant Pathology & Microbiology (ISU) - Biology (MTSU)

MIDDLE TENNESSEE STATE UNIVERSITY

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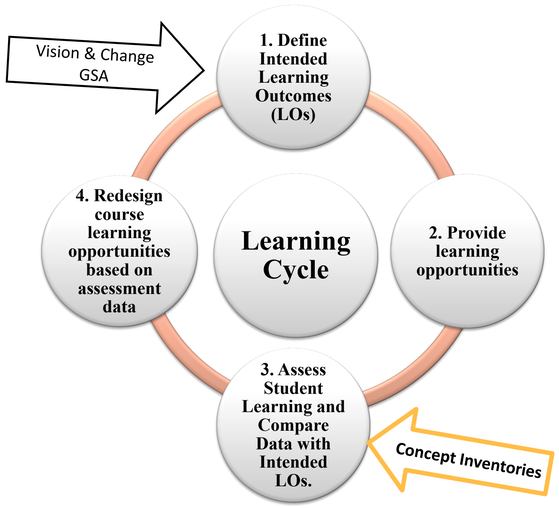
Tools for Assessment in Genetics: Making Instruments to Measure Student Understanding of Genetics

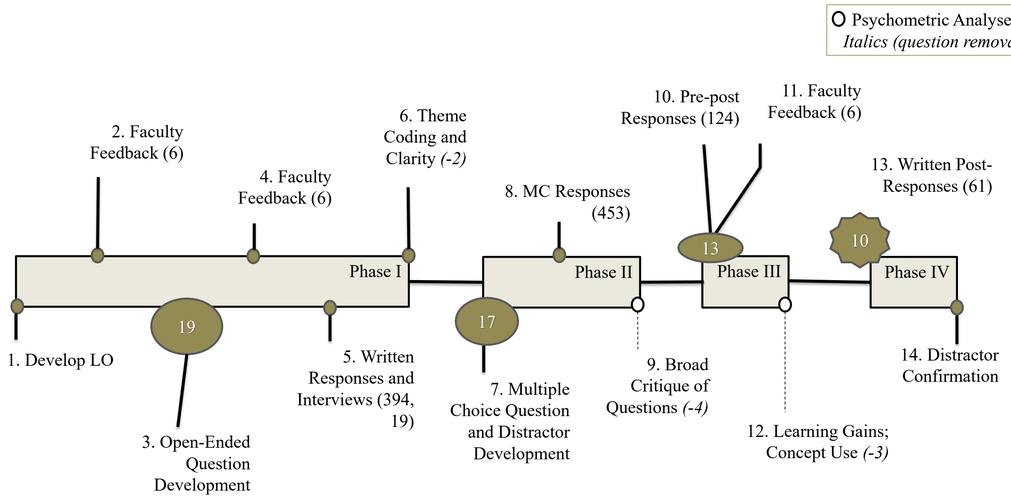
Assessment of student learning is a crucial part of the learning cycle of continuous improvement



Establishing Concepts and Learning Objectives

Mutation Concept	Learning objective Students should be able to:
Mutations are changes to DNA.	Define mutation.
Mutations can be point mutations or involve larger segments of DNA. These may or may not have different outcomes at the protein level.	Categorize changes to DNA and predict the outcome of these changes on a protein produced from the altered DNA using the genetic code.
In multicellular sexually reproducing organisms, mutations may occur in somatic cells or in germ-line cells.	Differentiate between somatic and germline mutations and predict the inheritance patterns of each type of mutation
Mutations may be induced by physical, chemical or biological processes.	Predict the nature of changes to DNA exposed to intercalating agents, base analogs, and radiation.

Iterative process of Instrument Development: Mutations Criterion Referenced Assessment



Collecting Open Ended Data and Coding Responses

LO3. Differentiate between somatic and germline mutations and predict the inheritance patterns of each type of mutation.

Renal cell carcinomas are associated with a translocation with Chromosome 3. **An error occurs the development of a kidney from stem cells (mitosis) which leads to a chromosome 3 translocation.** This causes a cluster of cancer cells to form in a man's right kidney. If this individual were to have children, would his kids have kidney cancer too? (Assume he had kids after he had cancer). Why or why not?

No, because the error occurred in a somatic cell.

Yes because the mRNA would be translated throughout his DNA and would be transcribed into his sex cells. This would cause his children to have the mutation.

No. Mitosis does not deal with the development of embryo

Crafting Multiple Choice Versions

Renal cell carcinomas are associated with a translocation of the end of chromosome 3 with the end of chromosome 8. An error occurs during the development of a kidney from stem cells (mitosis) which produces this chromosomal error. This causes a cluster of cancer cells to form in a man's right kidney.

9. If this individual were to have children, would his kids have kidney cancer too? (Assume he had kids after he had cancer). Why or why not?

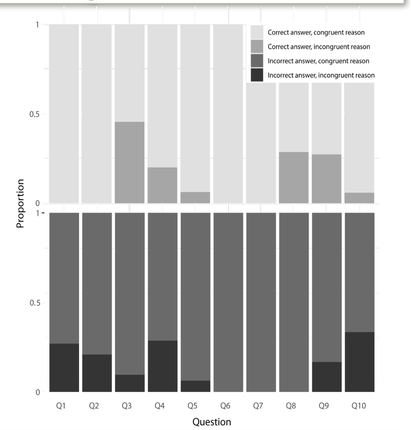
a. No. His children would not likely have kidney cancer because the mutation occurred in somatic cells rather than the gametes. (c)
b. Yes. His children would likely have kidney cancer because the mutation is dominant and the children were born after he had cancer. (M20)
c. No. His children would not likely have kidney cancer because the mutation is on an autosome, not a sex chromosome. (M19)
d. Yes. His children would be likely to have kidney cancer because all mutations are passed to the next generation. (M16)
e. It cannot be determined due to limited information. The mother's genotype would need to be determined to answer the question. (M5)

Psychometric Analyses

	Pre-Test (n = 285)			Post-Test (n = 301)		
Item	Item Difficulty	Point-Biserial	Item Discrimination	Item Difficulty	Point-Biserial	Item Discrimination
Q1	0.30	0.27	0.49	0.32	0.27	0.50
Q2	0.46	0.38	0.75	0.49	0.34	0.63
Q3	0.32	0.25	0.48	0.35	0.35	0.58
Q4	0.34	0.08	0.31	0.35	0.12	0.31
Q5	0.32	0.29	0.53	0.43	0.29	0.54
Q6	0.55	0.45	0.79	0.67	0.48	0.67
Q7	0.42	0.33	0.70	0.53	0.45	0.75
Q8	0.41	0.34	0.68	0.46	0.37	0.66
Q9	0.60	0.31	0.64	0.65	0.39	0.64
Q10	0.41	0.31	0.60	0.55	0.39	0.66
Mean	0.41	0.30	0.60	0.48	0.35	0.59

Congruence Testing: Do distractors capture the mistakes they were designed to detect?

Question	Probability
1	0.0036
2	0.0420
3	0.1723
4	0.0126
5	0.0020
6	<0.0001
7	0.0014
8	0.0006
9	0.0235
10	0.0025



Dissemination of this Work (Broader Impacts)

- Creation and Application of the Mutations Criterion Referenced Test (Accepted - Journal of Biological Education)
- Pedigree Analysis Criterion Referenced Test (Submitted – American Biology Teacher)
- Analysis of Student Misconceptions Surrounding Mutations (In preparation for Journal of Microbiology and Biology Education)
- Epistasis Criterion Referenced Test (In preparation for Biochemistry and Molecular Biology Education)
- Qualitative Analysis of Student Errors in Understanding Epigenetics (In preparation for CourseSource)
- Qualitative Analysis of Student Errors in the Application of Hardy Weinberg Equilibrium (In preparation for Evolution: Education and Outreach)

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