Why do students find genetics so difficult to learn?

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Possible reasons are discussed in the following slides

• Some familiar; some possibly not.
• Partially overlapping.
• Not in order of importance.
• Can we agree on the top 3 solutions?
1. Students unskilled at numeracy

- Manifested as inability to perform simple quantitative analysis.
- Definition of Numeracy = ability to apply basic mathematical concepts to real world problems.
- Involves classification, counting, measurement, proportions, probabilities.
- To see the world as a data set.
- To be able to quantify uncertainty.
2. Students have underdeveloped thinking skills

• What does this mean?
• Success in thinking is a function of
  – The clarity with which the task is presented and perceived.
  – Complexity of situation
  – Context
• Compare: Sudoku, the popular puzzle
Typical Sudoku Puzzle
3. Traditional study habits ineffective in genetics

- Past successes: note making copying, memorization, passive methods.
- Genetics demands higher levels in Bloom’s Taxonomy.
Bloom’s taxonomy

- Remembering
- Understanding
- Applying
- Analysing
- Evaluating
- Creating
4. Genetics uses an unfamiliar kind of assessment method for biology

• In short, PROBLEM-SOLVING.
• Problem-solving requires
  – deep understanding of concepts and vocabulary
  – Synthesis and making connections
  – High level of numeracy
5. Students have a poor grasp of genetics as a research endeavor

• Cannot distinguish well between:
  – The **body of knowledge** of genetics (the public view of genetics)
  – **Finding new things** by genetic analysis (our view of genetics)
6. Our teaching doesn’t adequately reflect the research slant, which gives context

- E.g. “Mendelian Genetics” is often taught as a time capsule, whereas in research today this kind of genetics is really about gene discovery through mutational dissection.
- E.g. Modified F$_2$ ratios often taught as “extensions to Mendel”, whereas in research they are about detecting interacting genes.
- Don’t stress discovering new things.
7. Students have little context with which to appreciate the research mode in biology

- At school and lower years, biology taught as an encyclopedia of knowledge.
- Science as a method of discovery not part of the pedagogy (e.g. “What makes people think this?)
- Few students have their own biology questions they want answered.
8. Textbooks do not present the research mode well

- Textbooks capsularize parts of the subject: integration to form a holistic view of genetics as mode of inference is not easy in a linear course sequence & gets inadequate attention.
- Textbook sequence doesn’t follow the mainline sequence of genetic analysis.
- Textbook publishers & writers resist change because instructors are conservative about sequence and content.
9. Genetics not integrated well into the curriculum

- Almost everywhere, genetics is taught as a stand-alone course.
- Genetics in research is mostly an approach to understanding some fundamental biological process; whereas in teaching it is a junk yard course of genetic “stuff”.
- Links to other biology, other science and to the arts are not easily achieved or promoted by curriculum.
10. Teaching doesn’t focus adequately on principles.

- There aren’t many. Here are 10; they are the principles that concern:
- *Mutation, segregation, assortment, linkage, interaction, complementation, replication, transcription, translation, regulation.*
- But they all require a deep working understanding.
11. Too much crammed into course and textbook

- (Corollary of the previous slide)
- There are many reasons for this; all hard to resist
- Crucial is the misconception that rigour is knowing a lot of stuff.
12. Not enough opportunity to interact with the genetic research role model: the professor

- A problem in all science, but particularly so in genetics because of the difficulties presented in previous slides.
- When working in a research lab, students metamorphose.
The Best way to Learn? The School of Athens (by Rafael)