

# 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

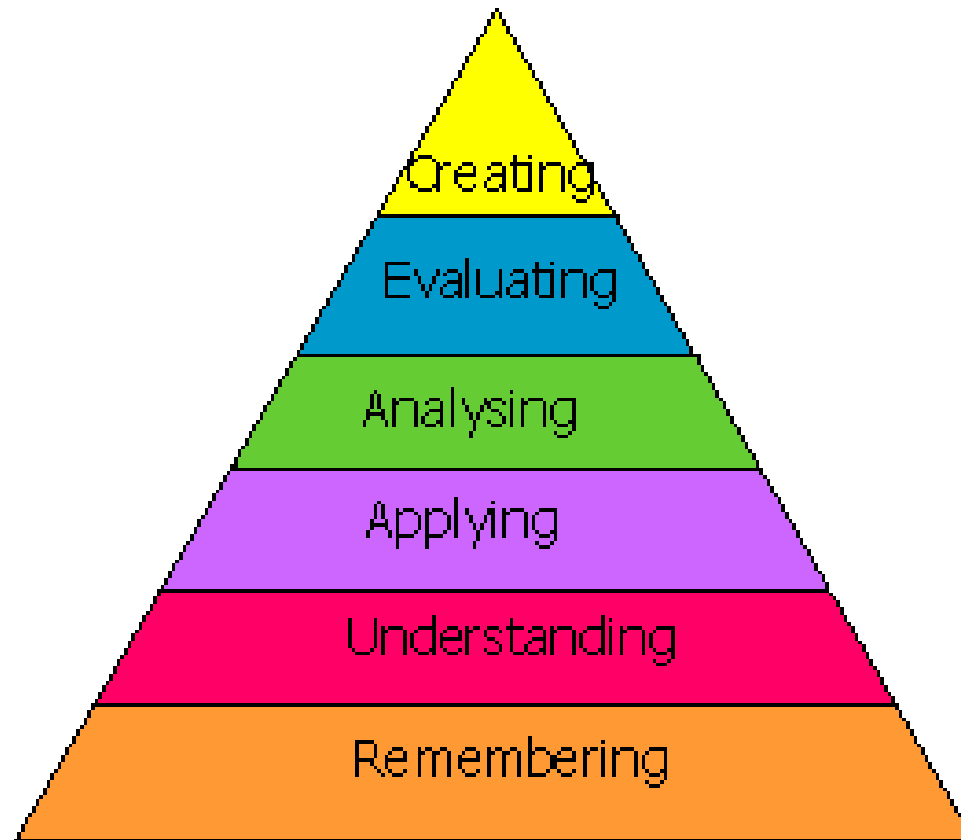
8			4		6			7
						4		
	1					6	5	
5		9		3		7	8	
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	4	8		2		1		3
	5	2					9	
		1						
3			9		2			5

### 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





# 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)

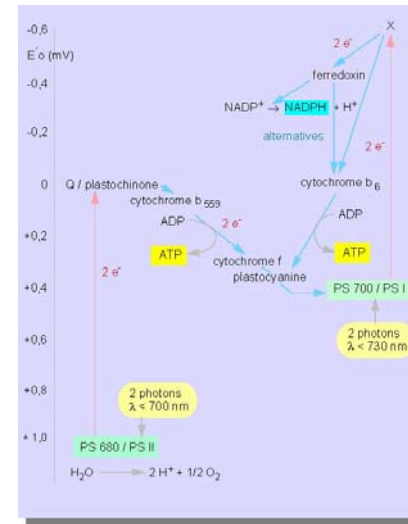
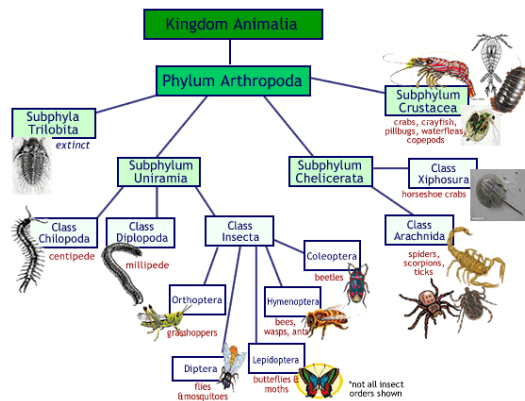
# 6. Our teaching doesn't adequately reflect the research slant, which gives context

- 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)

