# Undergraduate biology education: teaching more by talking less

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After four years of college, what should a college graduate be able to do?

# After four years of college, what should you be able to do?

be ready for more school!

Apply knowledge not just have it

think critically, analyze different situations

get job

discuss area of study (knowledgeably competently) & confidently

develop leadership skills

understand other cultures / diversity

cook a delicious meal

varies - person to person

manage time well

experienced w/ research & lab. letting understand scientific writing

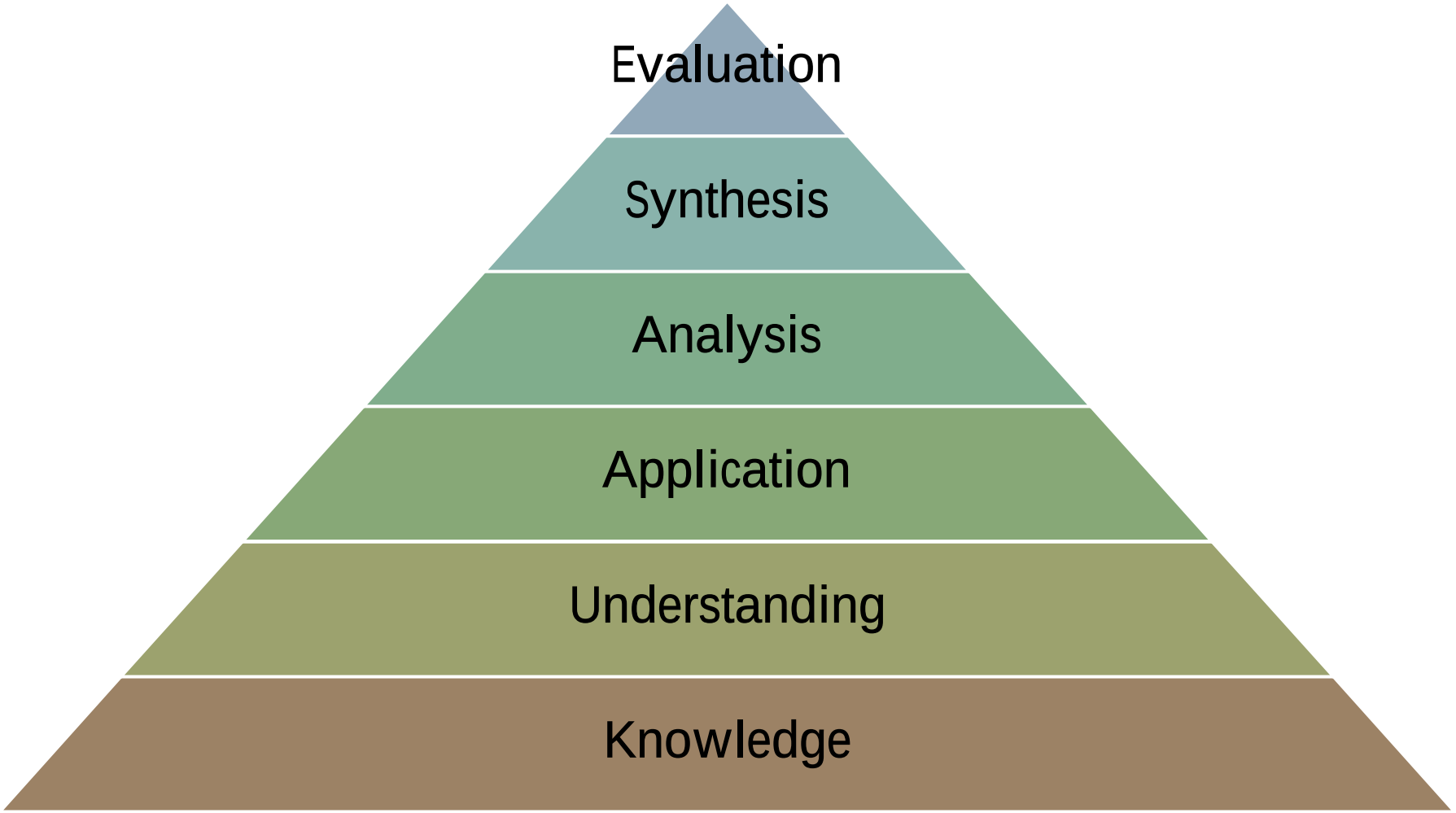
brave to write well

Vision & Change
A VIEW FOR THE 21st CENTURY
in Undergraduate Biology Education

**Frederico Unglaub, Student, University of Colorado**

- **Engage us**
- **Challenge us**
- **Help us develop critical thinking, analytical, and communication skills**
- **Make your learning goals transparent to us**
- **Provide opportunities for research**
- **Use analogies, not jargon**
- **Make learning relevant**
- **Give us ownership of our learning**
- **Infect us with your enthusiasm about the natural world**

# Where do these skills fit?



# Where did you learn how to do them? How do people learn?

- Prior knowledge: To learn something new, I have to use what I already know.
- Knowledge organization: How I organize my knowledge can help or hinder my understanding.
- Community: I can learn more in socially supported interactions.
- Motivation: My motivation to learn affects what and how much I learn.
- Difference: How I learn is not exactly the same as another person.
- Metacognition: I learn more when I consciously monitor my learning.

- See Chapter 6: Learning and Understanding: Seven Principles; NRC Council 2003, *Learning & Understanding: Improving Advanced Study of Mathematics and Science in U.S. High Schools;* see also "How People Learn" NRC Council 1999*)*

Foundations

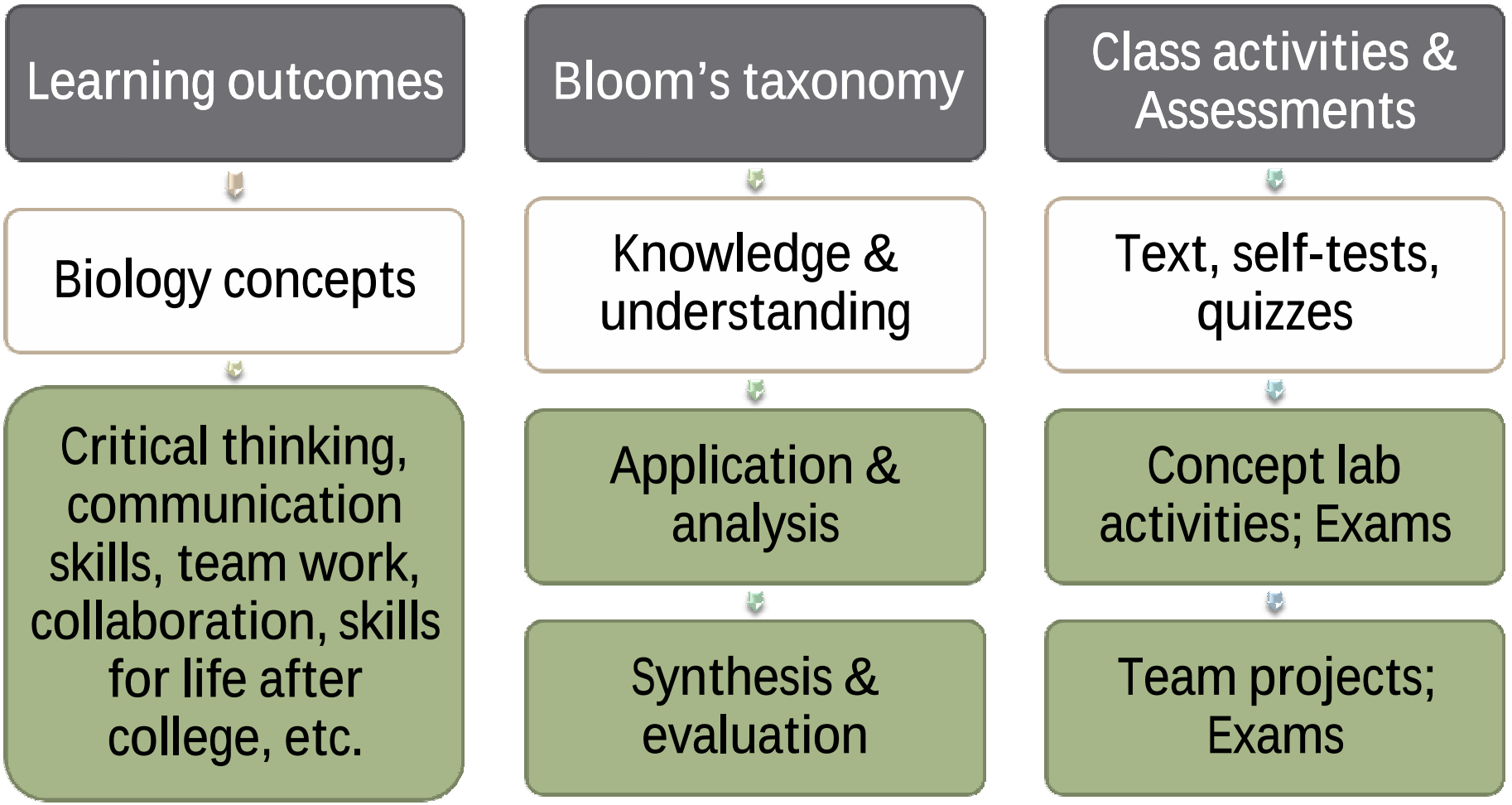
# Learn biology by being a biologist…

# What are the learning outcomes of Foundations?

You will…

- Learn foundational biology concepts in an evolutionary context
- Develop foundational skills needed for success in science & future careers
  - Problem solving, critical thinking
  - Data analysis & interpretation
  - Laboratory skills & experimental design
  - Team work & Communication
  - Quantitative reasoning

# What's different about Foundations?



# How do the course activities fit together?


- Study guides
- Text book
- Web-based resources
- Self-tests

- Quiz
  - Individual
  - Team

- Problems
- Simulations
- Videos
- Data Analysis
- Discussions
- Models
- *etc.*

- Outline
- Abstract
- Poster
- Presentation
- Take home exams

# Application & Analysis Activities

Problems

Simulations

Videos

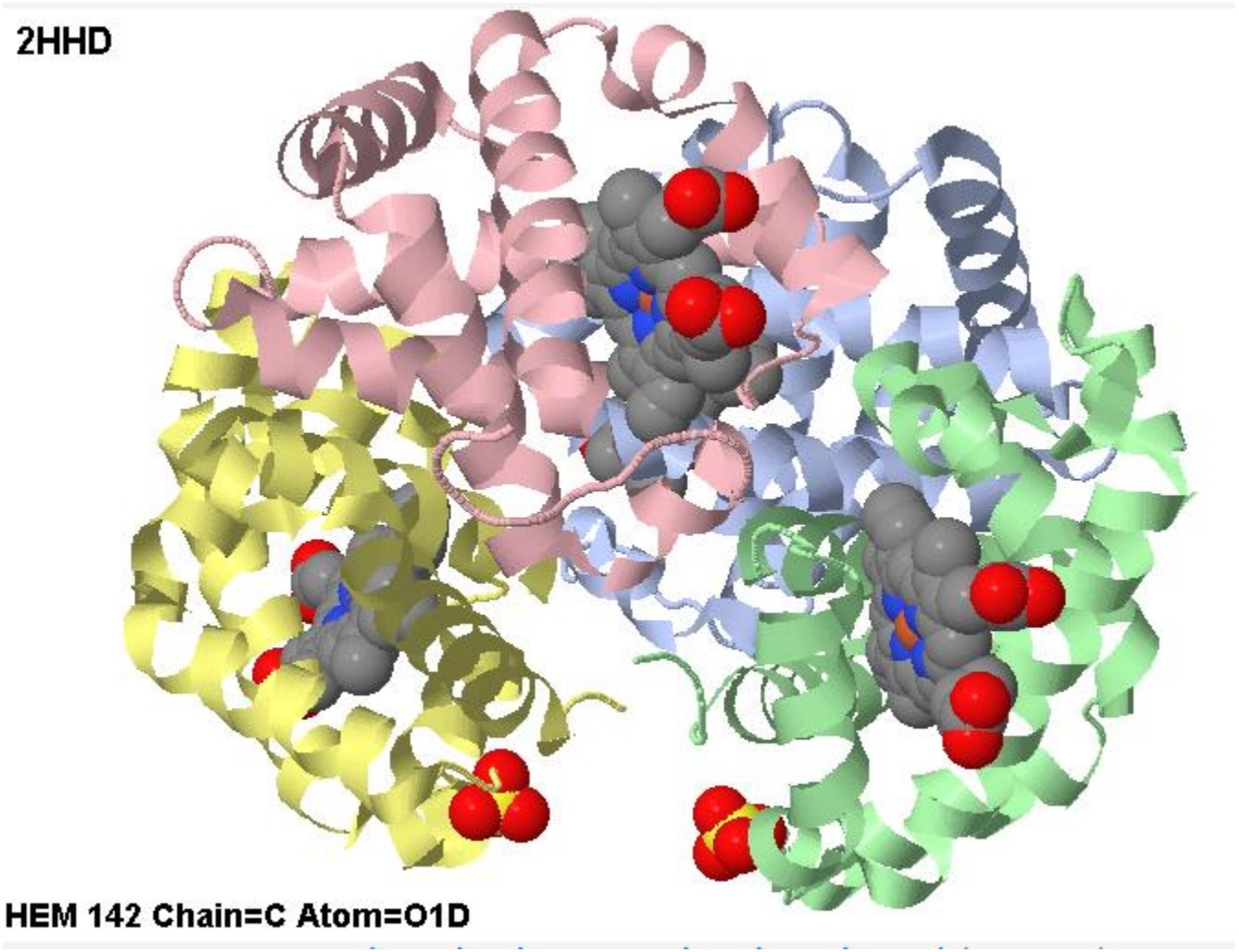
Data Analysis

Discussions

Models

*etc.*

# Inquiry 2: Let's explore a protein!




http://molvis.sdsc.edu/fgij/fg.htm?mol=2hhd

# Synthesis & Evaluation Activities

- Take home exams
  - Post exam analysis
- Team projects
  - Peer/Self/Expert Evaluation
  - Revision

# Synthesis & Evaluation Projects

- Nature of science
  - Recommend whether the NIH should invest more funds for research into the cause, prevention, and cure of Chagas Disease

# Synthesis & Evaluation Projects

- Cell structure & basic evolutionary principles/mechanisms
  - Recommend a strategy to develop a new antibiotic for XDR-TB (MRSA) that will escape evolution

# Synthesis & Evaluation Projects

- Gene structure/expression & evolution
  - Identify a problem of social value and solve it using genes


Expected Results
Why manipulate this gene?
Team
2 - 12


Gene
Yeast Vector With inserted MOG Gene
Proposed "Camouflage" Gene
pET-3a
4.2 Kb
Continued Research
1--5

# Harness the awesome power of undergraduates as dreamers…

- “how could you make money with this observation”
- http://igem.org/About
- http://ciber.berkeley.edu/faculty-and-staff/robert-j-full/