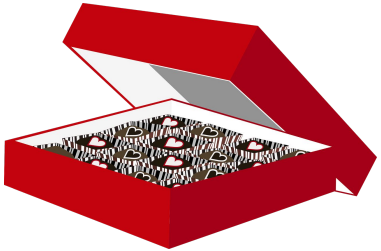


A "Box of Lessons"

for Exploring Biomolecular Structure and Function

Keith Johnson, Bradley University, USA; ***Alexandra Pettit***, Carleton University, Canada;
Sheela Vemu, Waubonsee Community College, USA; ***Shuchismita Dutta***, Rutgers University, USA

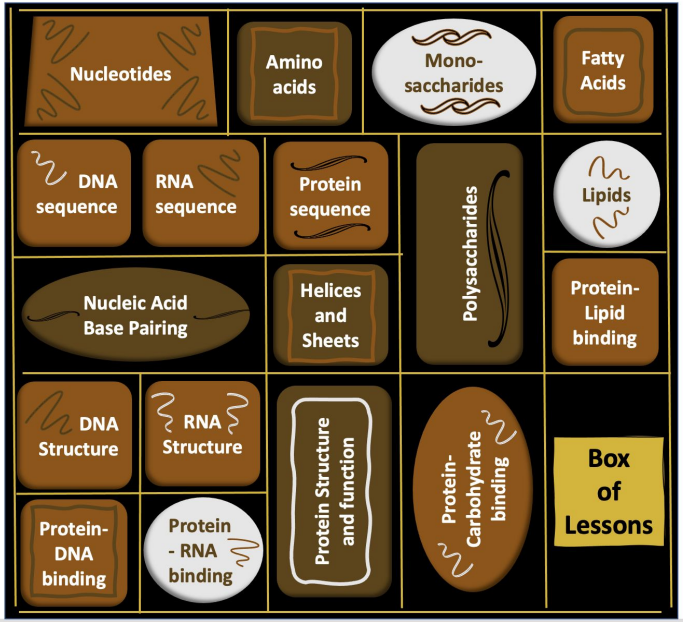
SPARKING IDEAS
BIOME Institute 2022

BioQUEST CURRICULUM CONSORTIUM

Inclusive, Diverse, Equitable, and Accessible Communities in STEM Classrooms

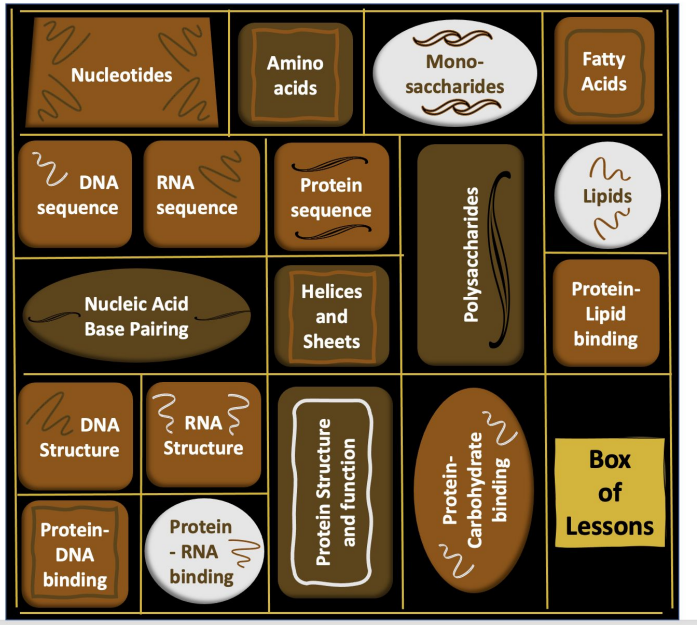
Overview

- Introductions
- The “Box of Lessons”
- Hands-on explorations
- An Invitation



Overview

- Introductions
  - About us
  - Motivation for the “Box of Lessons”
- The “Box of Lessons”
- Hands-on explorations
- An invitation



About Us

This project was a collaborative effort of members participating in the Molecular CaseNet Spring 2022 Faculty Mentoring Network. A few of us are here to present this work.

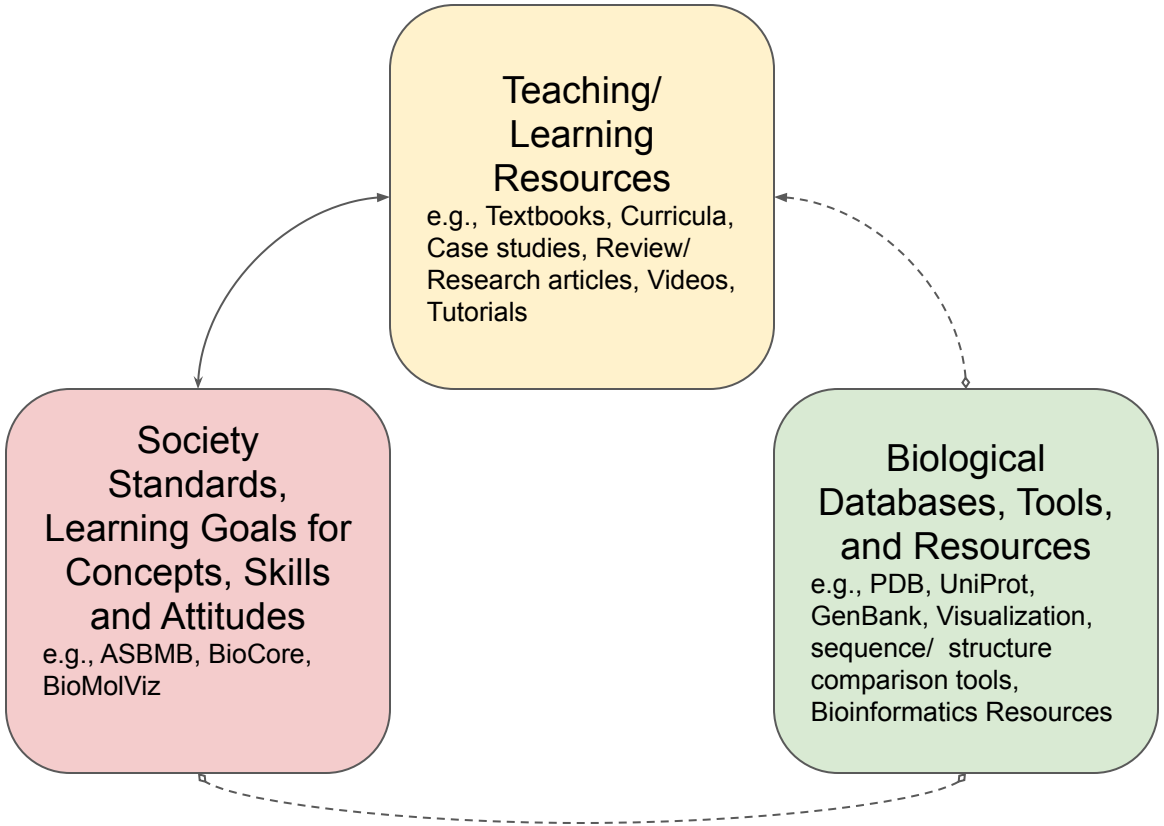
Keith Johnson
Bradley University

Alexandra Pettit
(she/her)
Carleton University

Sheela Vemu (she/her)
Waubonsee
Community College

Shuchismita Dutta
(she/her)
Rutgers University

Preparing Students to Learn Independently, Discover, Innovate



Motivation for the “Box of Lessons”

- Free (OER)
- Engage students in active learning
- Help in teaching/learning introductory level UG courses in Biology/Biochem
- Literature based examples to explore biomolecular structure and function
- Uses data and tools from open access data resources
- Variety of lessons to match curricular themes and student needs
- Provides a template to develop lessons on new topics (as needed)
- Can be used in public, private, and community colleges and universities

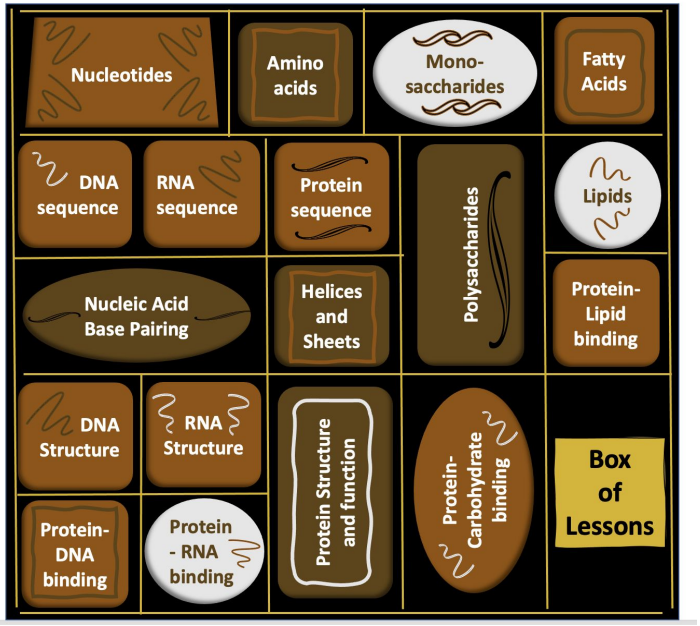
RCSB PDB PROTEIN DATA BANK

Molecular CaseNet

QUBES A BioQUEST Project

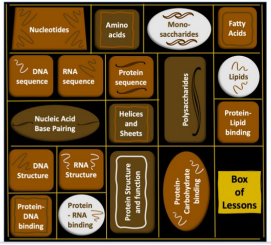
Overview

- Introductions
- The “Box of Lessons”
  - What is in it?
  - Possible ways to use it?
- Hands-on explorations
- An invitation



What is in the “Box of Lessons”?

- An evolving/growing collection of learning materials and activities
  - Includes a student version + a version with teaching notes and answer keys
- Help explore connections between biology and chemistry
- Introduction to public bioinformatics resources
- Introduction to visualization of biological macromolecules

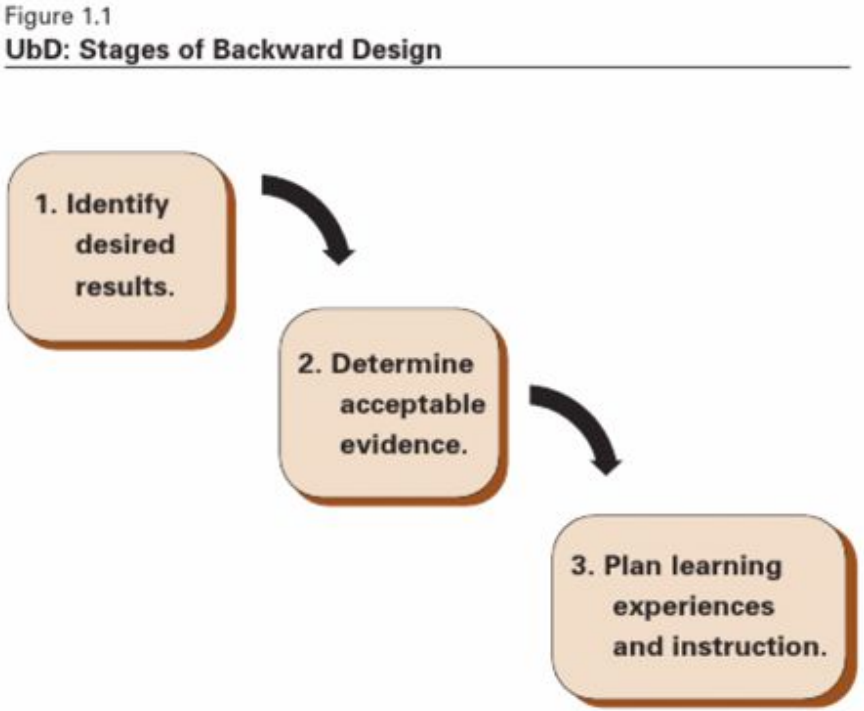


Type of Biomolecule	Activities	Learning Materials
Biological Macromolecules	• Interrogating the PDB •	• Types of Biological Molecules
Proteins	• Exploring Amino acids • Protein Sequences • Helices and Sheets • Insulin Structure and Function • Hemoglobin Structure and Function • Trypsin Structure and Function	• Amino Acids in the PDB • Exploring Levels of Protein Structure in the PDB
Nucleic Acids	• Exploring Nucleotides • Base Pairing • DNA Sequence and Structure • RNA Sequence and Structure • DNA Structure and Function • RNA Structure and Function	• Nucleotides in the PDB • *Nucleic Acid Base Pairs* • *Introduction to Nucleic Acids - DNA and RNA* • *DNA* • DNA Conformations: A-, B-, Z-DNA
Carbohydrates	• Monosaccharides • Polysaccharides in the PDB	• *Exploring Carbohydrates in the PDB Archive* (PDB-101)
Lipids	• Fatty Acids • Exploring Membranes	• Lipid like molecules in the PDB • *Membrane Protein Resources* (PDB)
Complexes	• Protein DNA binding • Protein RNA binding • Protein Carbohydrate binding • Protein Lipid binding	

Using the “Box of Lessons”: Backward Design Model

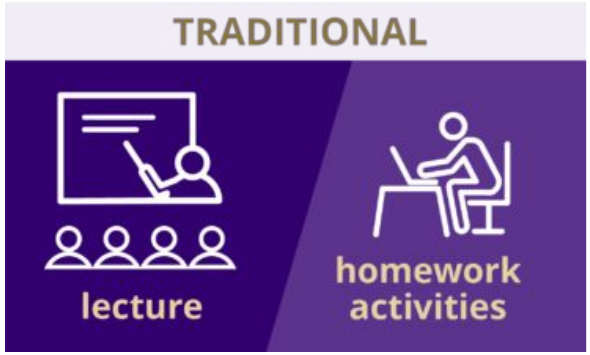
What do I want students to be able to do that will stimulate exploration through inquiry?

- What struggles or misconceptions do students have about this challenging topic?
- How can we assess how students' reason about this topic or if they have misconceptions or alternative ideas?
- What prior knowledge and reasoning resources do students have to help them learn this challenging topic?
- What teaching strategies or resources can we use to support students’ learning of this topic?

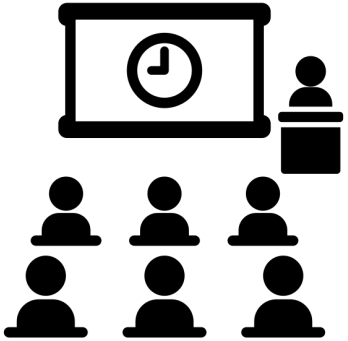


Using the “Box of Lessons”

How to use these?



Lab Exercise



Authentic Assessment

Using the “Box of Lessons”

How to use these?

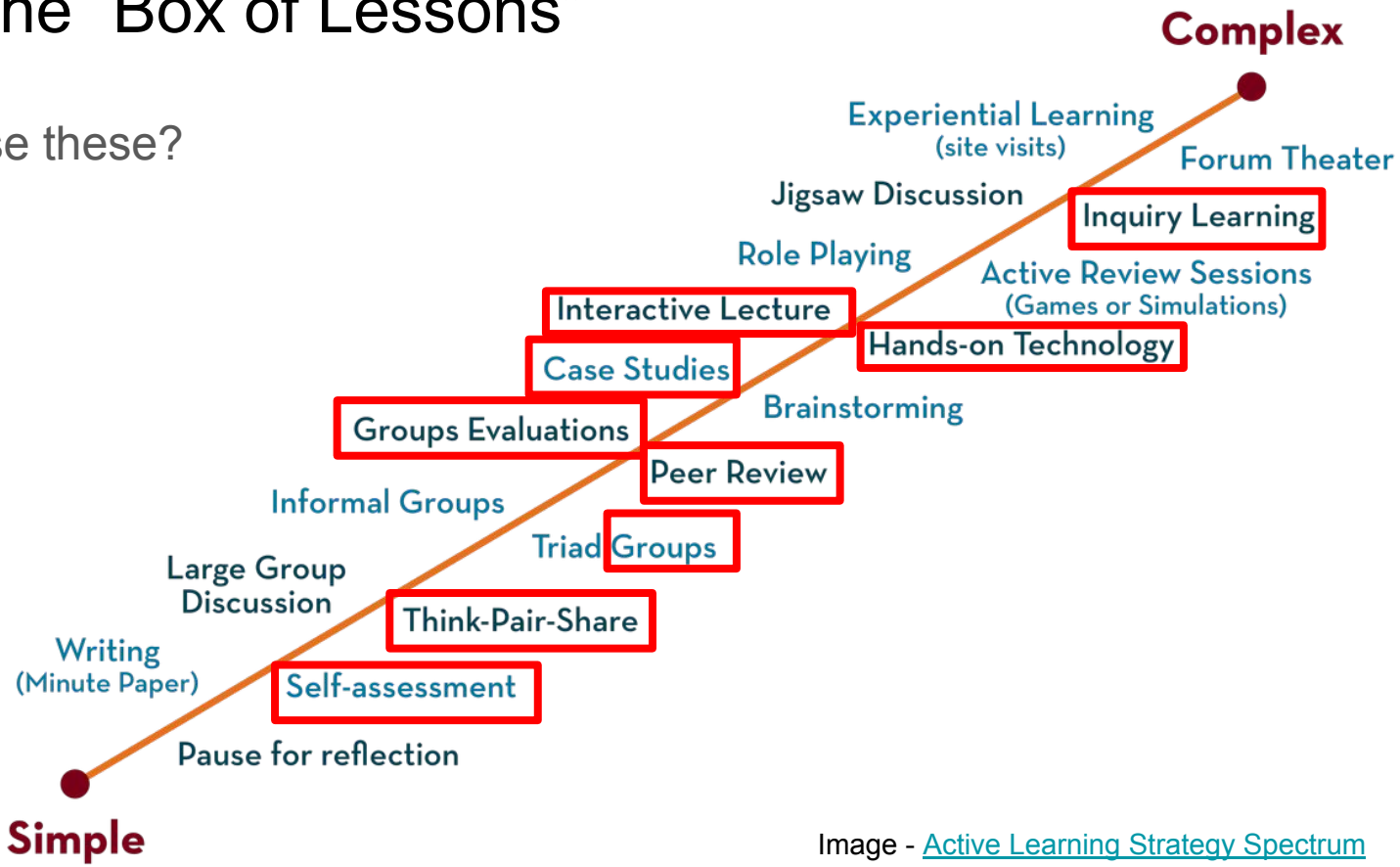
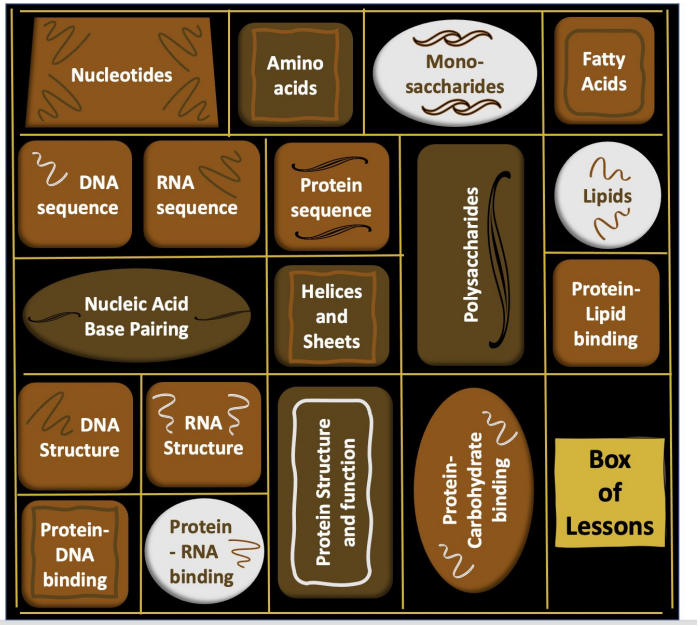


Image - [Active Learning Strategy Spectrum
University of Minnesota Center for Educational Innovation]

Overview

- Introductions
- The “Box of Lessons”
- Hands-on explorations
  - *In breakout rooms*
- An invitation



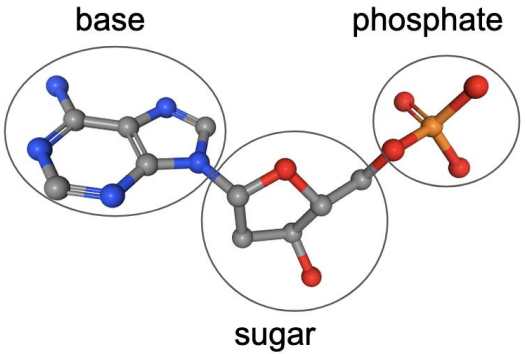
Choose your Breakout Room

Breakout Room 1

RCSB PDB
PROTEIN DATA BANK

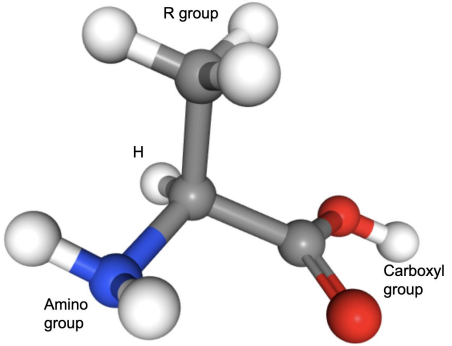
Interrogating the PDB

Breakout Room 2



Exploring Nucleotides

Breakout Room 3



Exploring Amino Acids

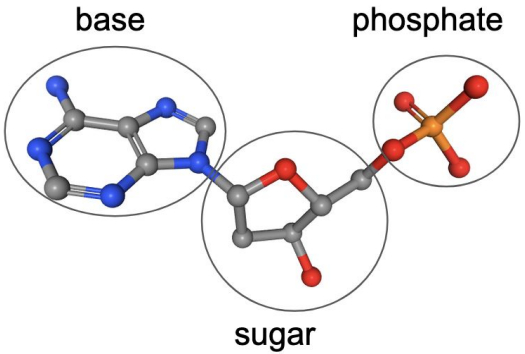
Return from Breakout Room

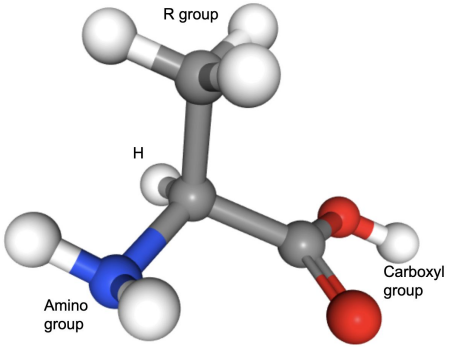
Breakout Room 1

Breakout Room 2

Breakout Room 3

RCSB PDB PROTEIN DATA BANK



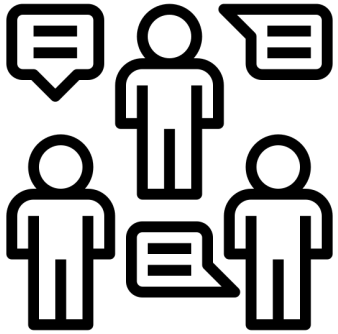


Interrogating the PDB

Exploring Nucleotides

Exploring Amino Acids

Breakout Room Discussion Report Back



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Overview

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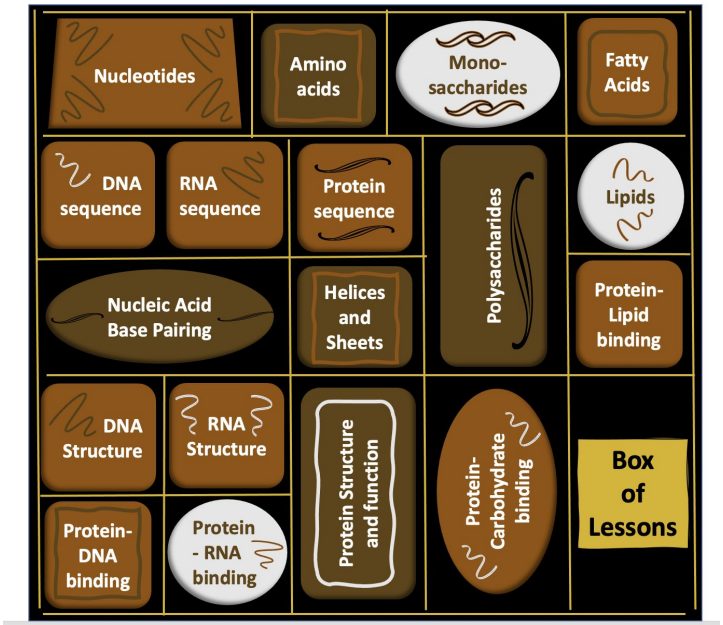
- The “Box of Lessons”
- Hands-on explorations
- An invitation to …
  - Pilot the lessons
    - How would you use it?
  - Contribute to the collection



Contact us

A beta-version of all the lessons will be available for piloting in Fall 2022

Are you interested in piloting these exercises in the upcoming academic year?

Write to Shuchi at sdutta@rcsb.rutgers.edu

Want to learn more about Molecular CaseNet?

Visit Website: https://molecular-casenet.rcsb.org/

Write to Shuchi

Summary

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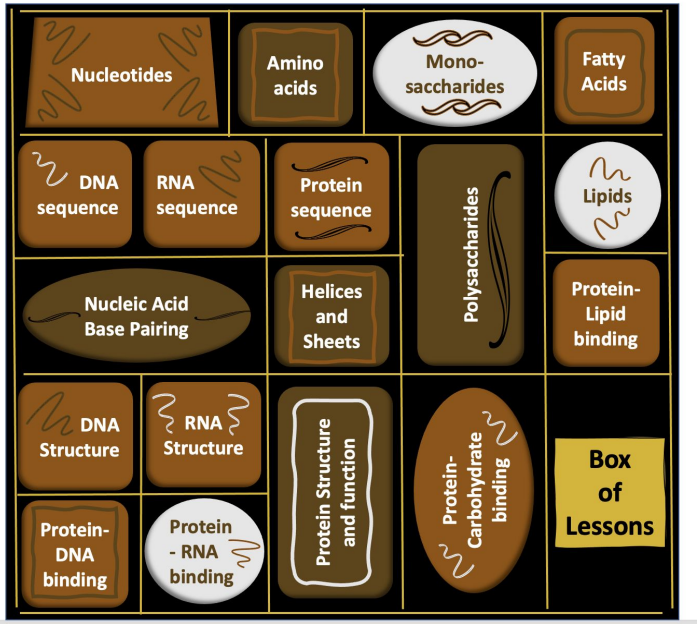

Acknowledgements

- Molecular Casenet is supported by the National Science Foundation - DBI 1827011; DBI 2018884
- All members of the Molecular CaseNet Spring 2022 QUBES FMN inspired and contributed towards the development of the “Box of Lesson”
    - Several members are still engaged in completing the lessons for pilot testing in Fall 2022.
- The RCSB Protein Data Bank team works to bring data, tools, and resources to researchers, educators, students, and the curious public.