ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Klymkowsky Revisited

How do ETH students compare to US students on the understanding of molecular biology principles

Christian Bohr, Claudio Brunold, Ilan Oppenheim, Simon Tscharner

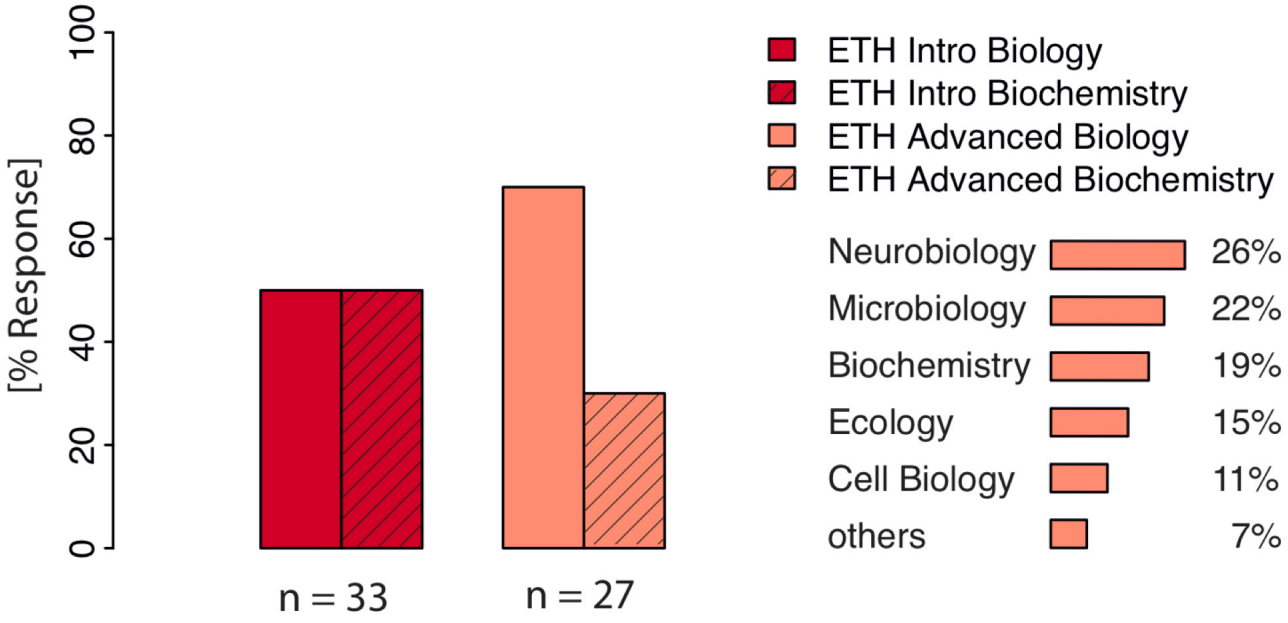
Questionnaire

- 10 multiple-choice questions
  - based on the Biology Concept Inventory (BCI)*
  - students USA: introduction and advanced
  - students ETH: undergraduate and graduate

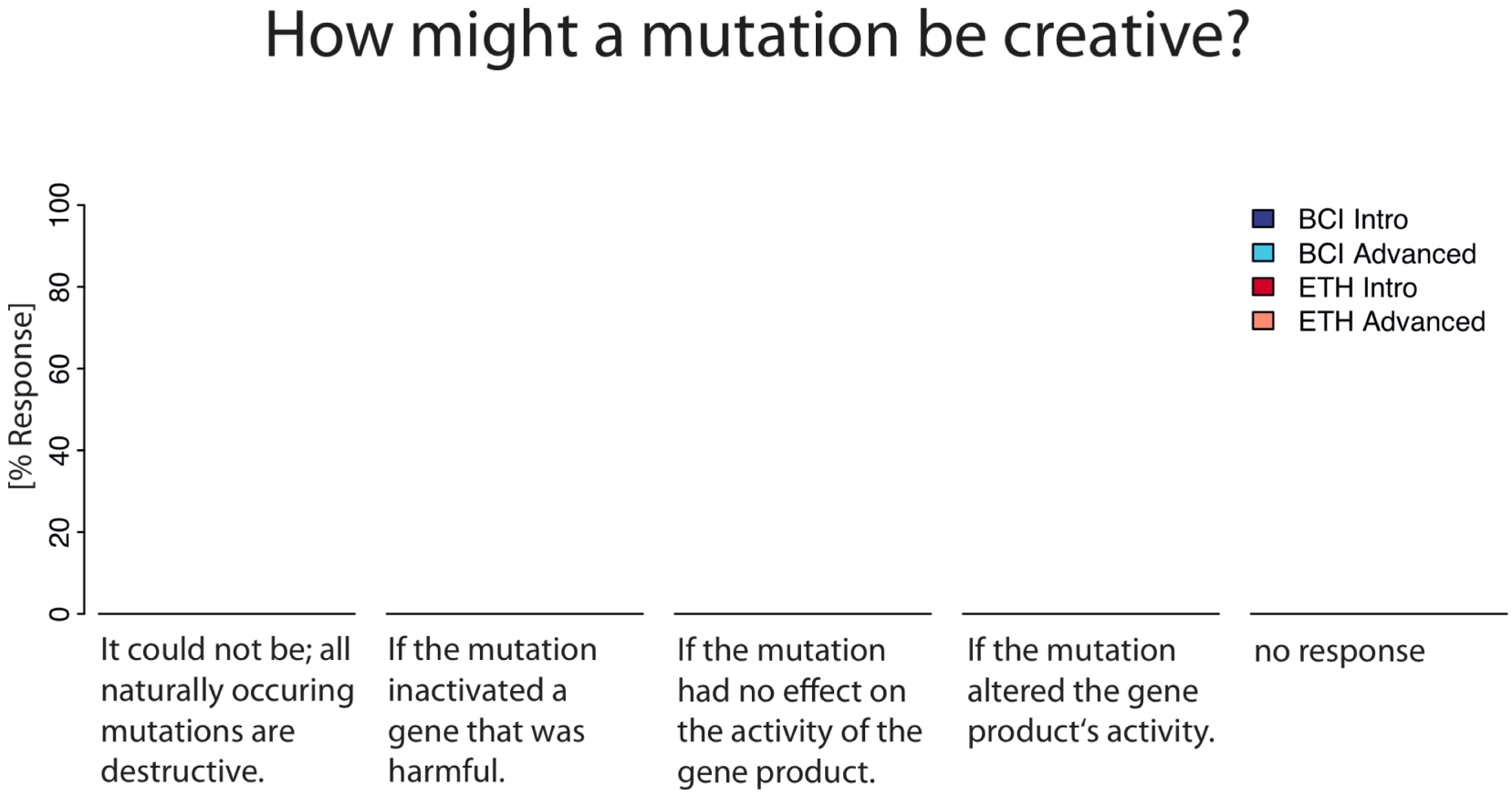
- Important molecular principles
  - Biology (e.g. mutation)
  - Chemistry (e.g. DNA)
  - Physics (e.g. molecular interactions)

*Klymkowsky et al., 2009. *Understanding the roots of molecular creativity and evolutionary change: what are the inherent and instruction-induced conceptual barriers and curricular omissions?*

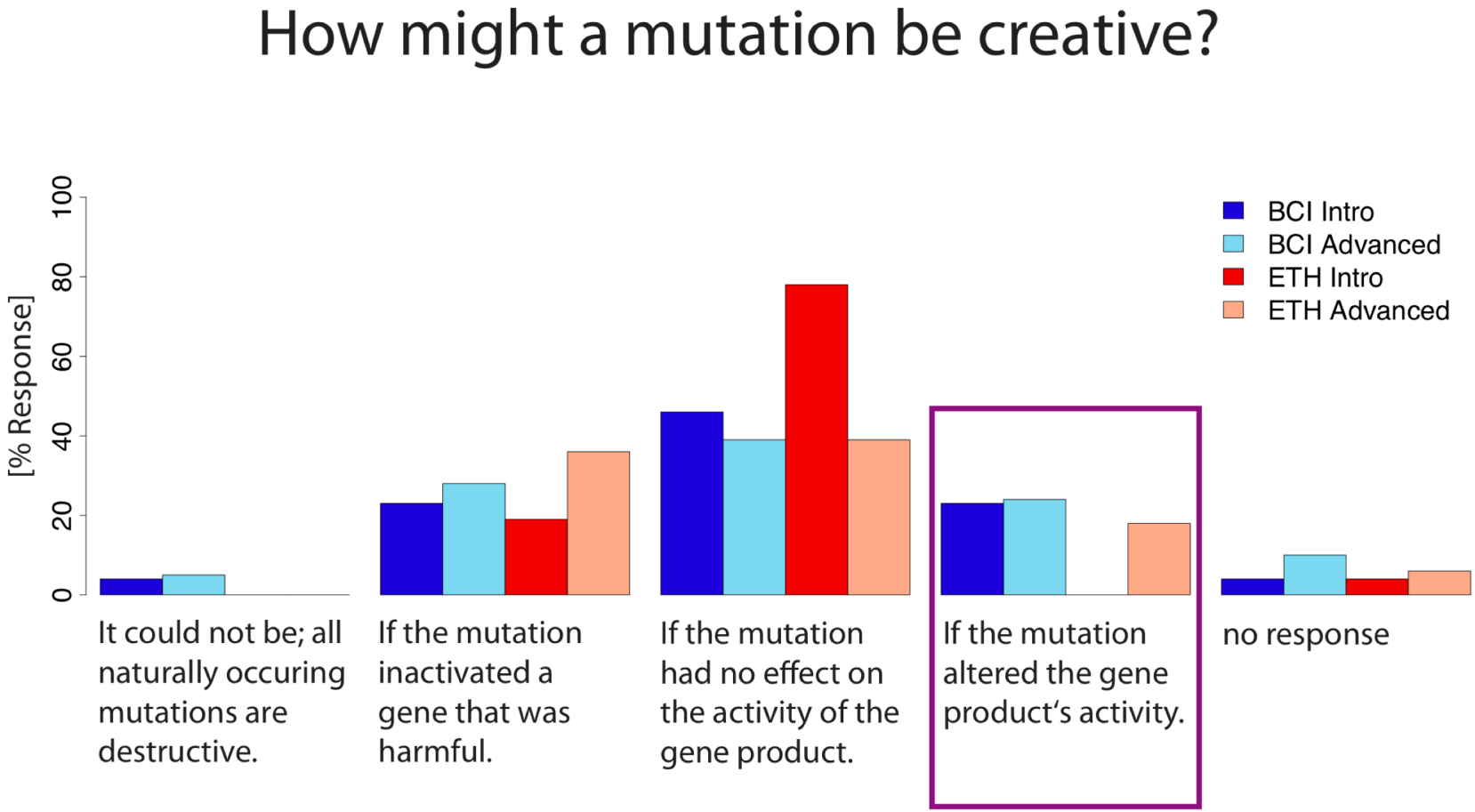
ETH Biology Students



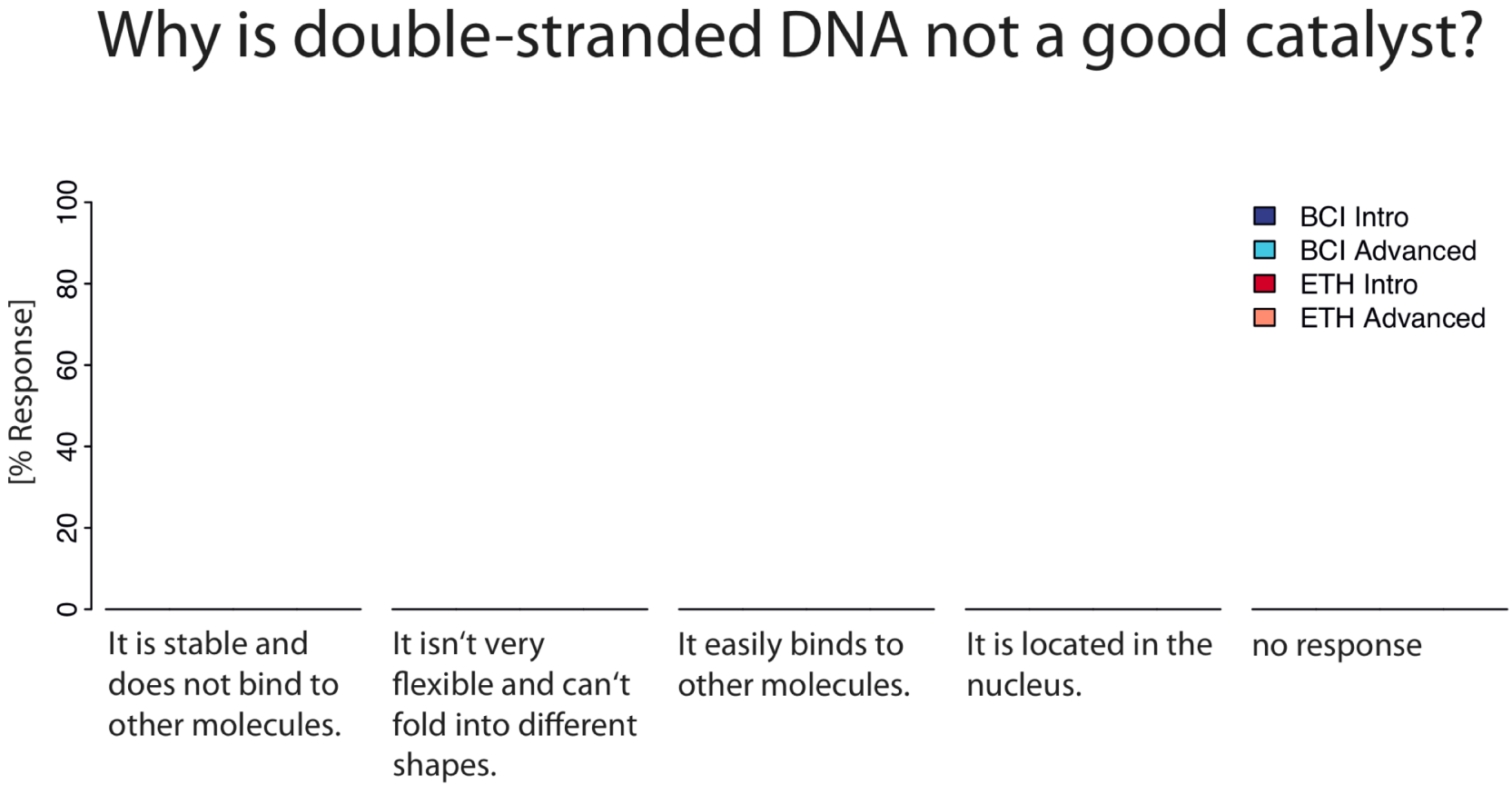
Example 1: Mutation



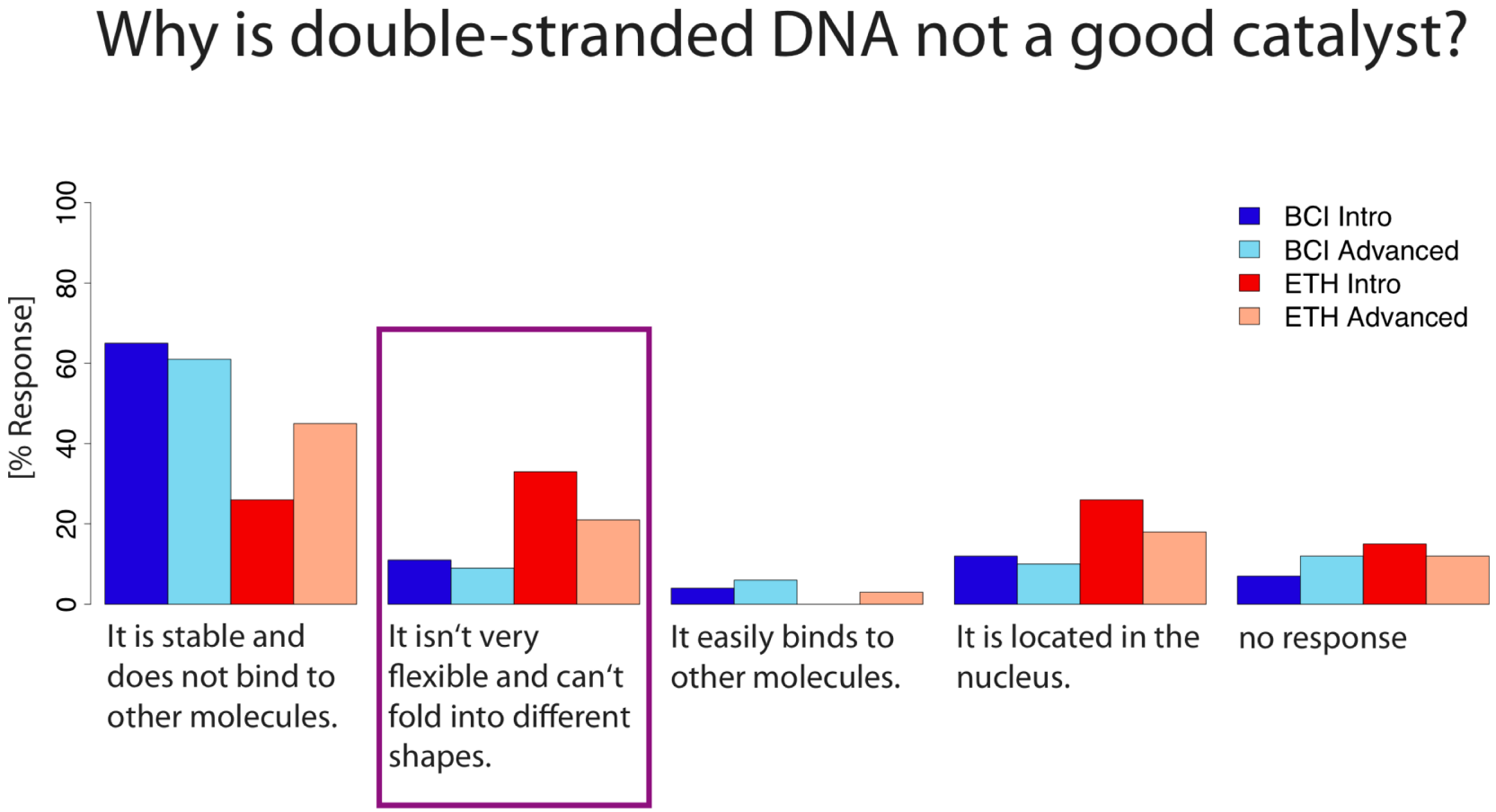
Example 1: Mutation



Example 2: DNA

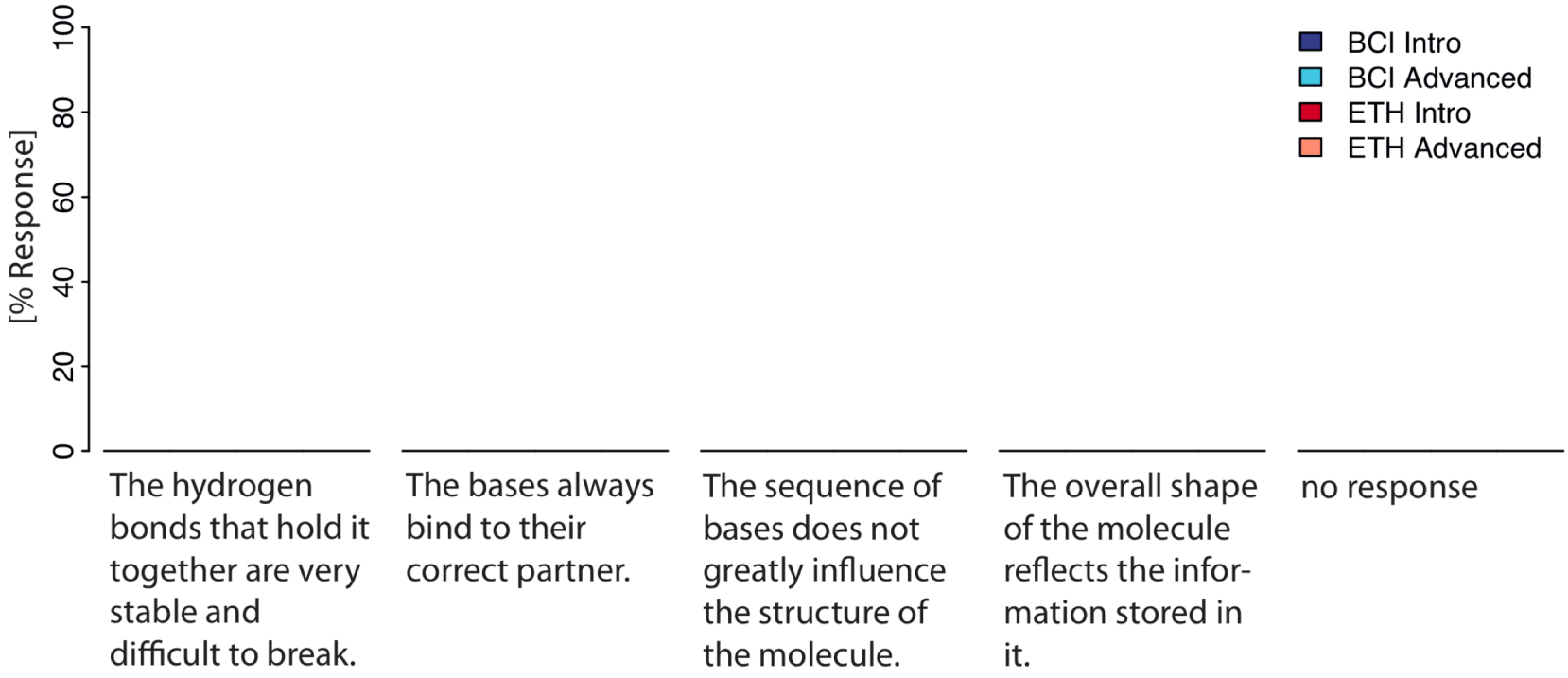


Example 2: DNA



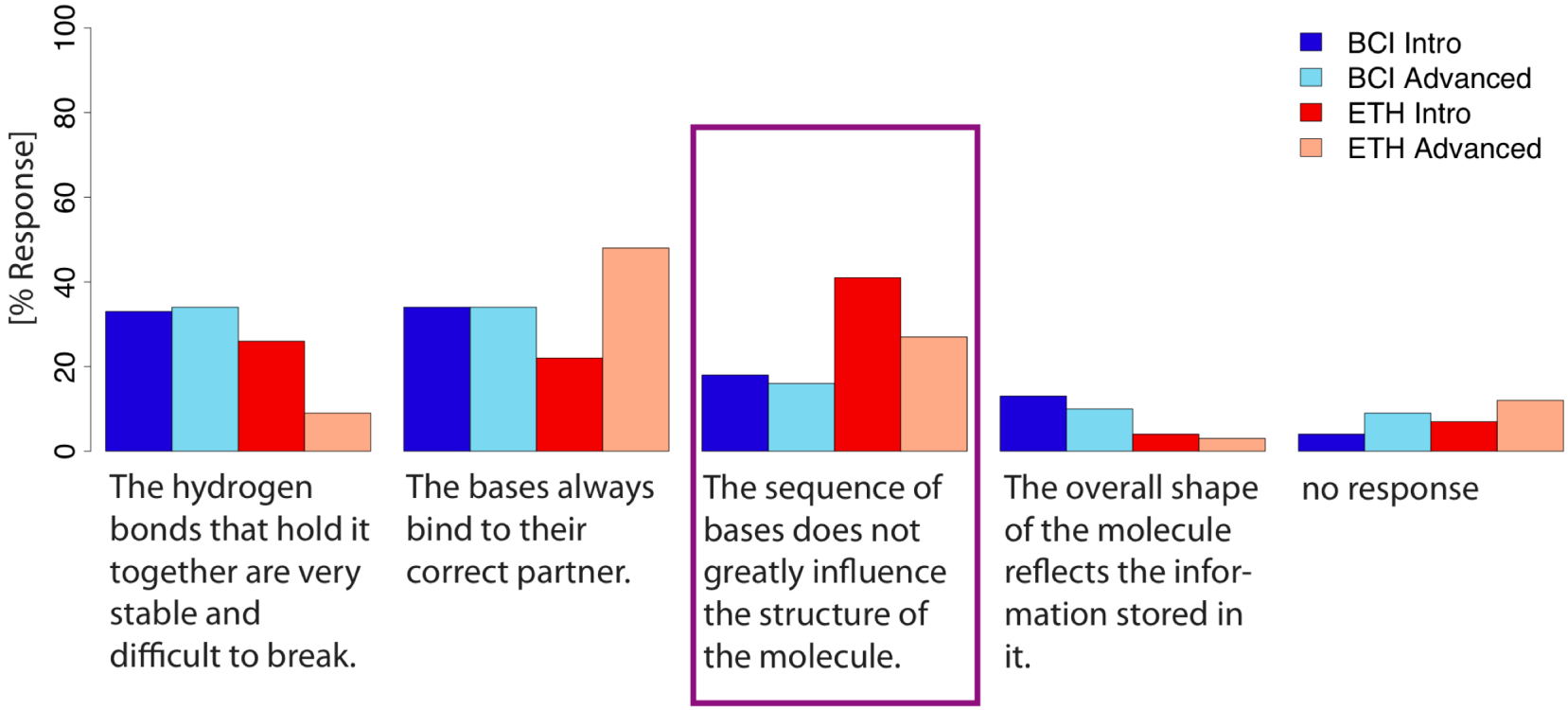
Example 2b: DNA

What makes DNA a good place to store information?



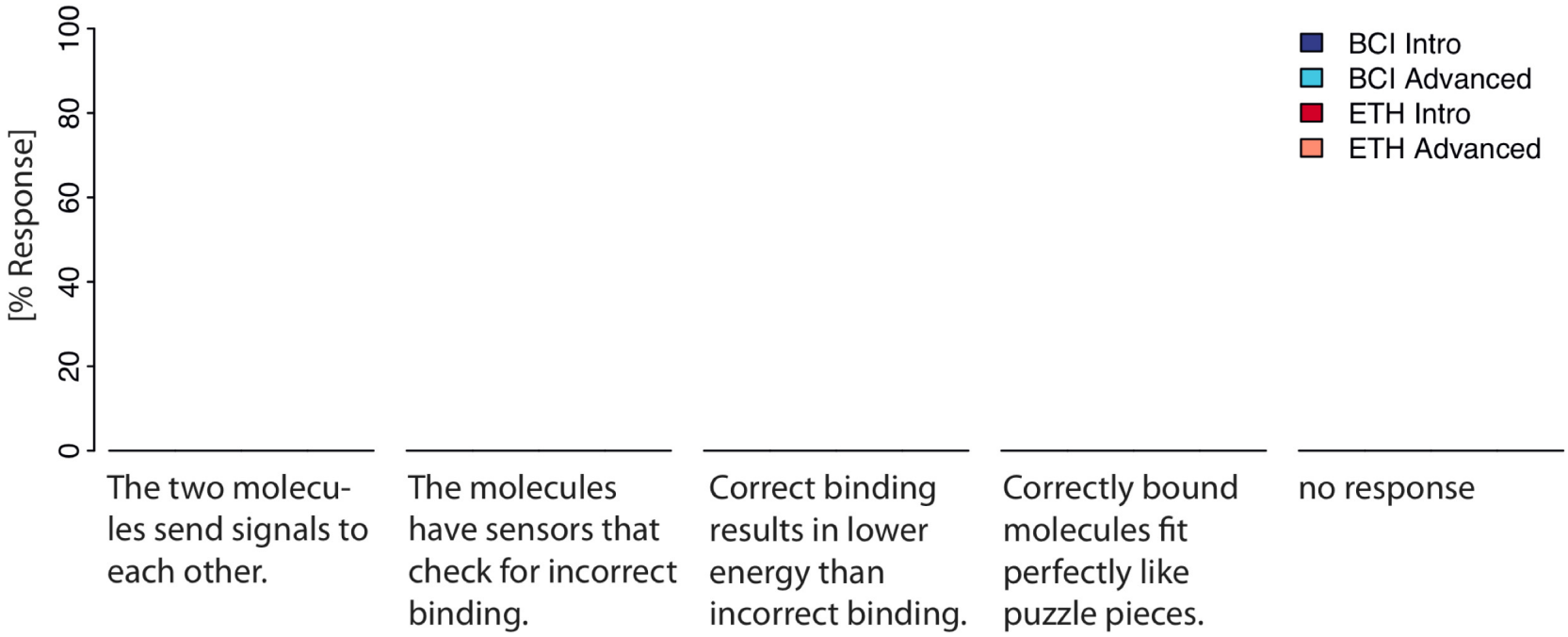
Example 2b: DNA

What makes DNA a good place to store information?



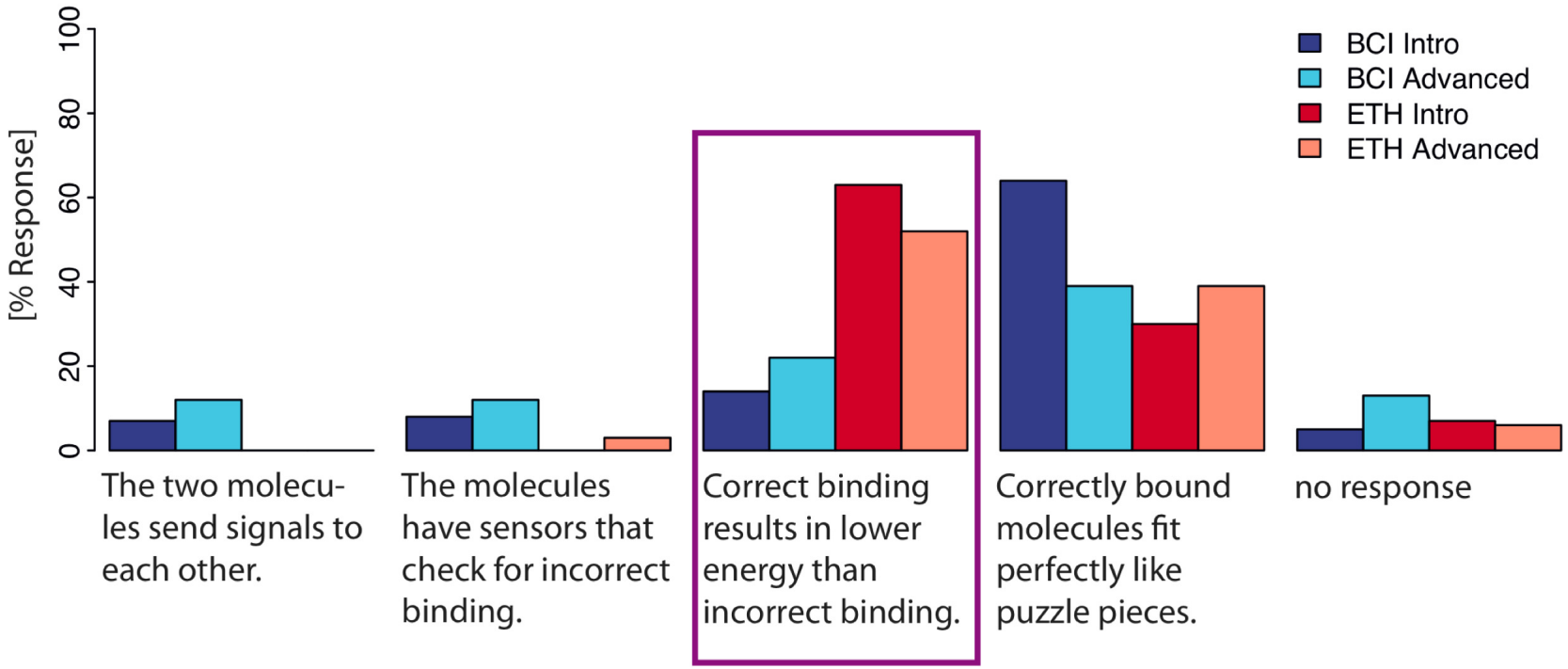
Example 3: Molecular interactions

How does a molecule bind to its partner and avoid „in-correct“ interactions?



Example 3: Molecular interactions

How does a molecule bind to its partner and avoid „in-correct“ interactions?



Learnings

- **Situated cognition**
  - When presented with good lures, students are distracted from simple logic thinking (e.g. creative mutation)
- **Instruction-induced misconceptions (didaskalogenic)**
  - Models for demonstration might be misleading (e.g. jigsaw pieces)
- **Interdisciplinary integration**
  - Knowledge of physics helps to understand molecular bindings.

Implications for Teaching

1. Take on a system perspective
   - Do not restrict on teaching isolated subjects
   - Include co-players (e.g. interactions)

2. Consider multiple disciplines
   - Treat biological principles also in e.g. physics class
   - Disciplines should benefit from each other

3. Include concepts of energy
   - Challenging but important
   - Reduce teleological thinking (emphasize the role of randomness)

Thank you for your attention!

Ilan Oppenheim, Simon Tscharner, Claudio Brunold, Christian Bohr

Students at the Teaching Education Program ETH Zurich
Learning and Instruction, Prof. Elsbeth Stern

Example 3b: Molecular interactions

Once two molecules bind to one another, how could they come back apart again?