Genetically Modified Organisms and the Regulation of Gene Expression

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LAB-AIDS INCORPORATED EXPERIENCING SCIENCE

SEPUP

Science Education for Public Understanding Program

- Science curriculum design and professional development
- Based at the Lawrence Hall of Science, University of California at Berkeley
- Designing science curriculum, working with teachers, and supporting quality science instruction since 1983
- Major funding for curriculum work from the National Science Foundation

Lab-Aids, Inc.

- Publishes and supports the use of SEPUP materials in classrooms across the United States
- Publishing quality science curricular materials, providing curricular support since 1963
- Based in Ronkonkoma, New York

Science and Global Issues (SGI)

- NSF curriculum development project
- Uses sustainability as the unifying context for studying important biological concepts
- Inquiry-based, issue-oriented science…
    - Students talk, think, and discuss content as it relates to personal, societal, and global issues
    - Students learn to use evidence in the decision-making process
- Embedded assessments and literacy strategies
- Research-based and extensively field tested

Science and Global Issues: Biology

Unit	Content focus	Sustainability focus
Sustainability	Interdisciplinary	Sustainability from a personal, community and global perspective
Living on Earth	Ecology	Human influence on ecosystems
World Health	Cell Biology	Global health issues
Feeding the World	Genetics	Use of genetically modified organisms
Maintaining Diversity	Evolution	Changes in and threats to biodiversity

Sustainability

- In the context of human development:
  - Meeting the needs of the present without compromising the ability of future generations to meet their own needs
- Examined through three perspectives:
  - Environmental, economic, and social
- Considered on three levels:
  - Personal, community, and global

Activity: Cell Differentiation and Gene Expression

- Occurs late in the unit (Activity 17)
- Students have basic understanding of major genetic concepts
- In previous unit, students learned that specialized cells have characteristic proteins
- Students comfortable with 4-2-1 model and literacy strategies
- Several case studies already covered

Getting Started (5 minutes)

Discuss with your partner:

1. How many different kinds of cells do you think there are in the human body? Try to name at least four kinds.
2. In what ways are the cells you listed:
   a. Similar to each other?
   b. Different from each other?
3. If they all have the same DNA, what makes these cells have different proteins?

You have already learned. . .

- All cells in an individual organism have the same genes (DNA) in their nuclei: In other words, your liver, skin, muscle, nerve, and developing blood cells all have the same DNA.
- But, each type of specialized cell produces characteristic proteins.

Challenge

- How does the same set of genes direct the activities of 220 human cell types?

- Another way to think of this question is:

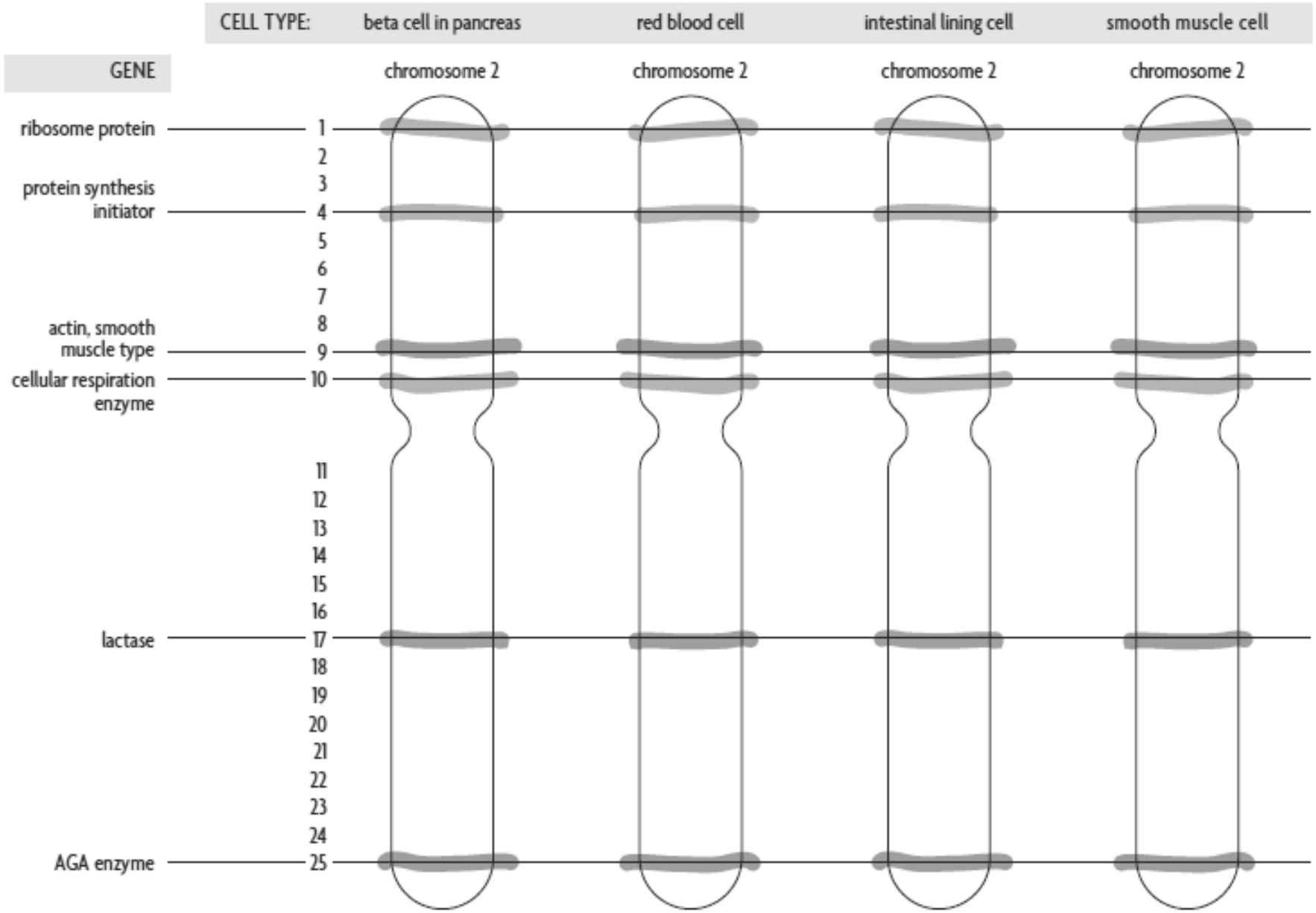
  What processes ensure that each type of cell only produces the set of proteins it needs?

Introduction (5 min)

- Read the Introduction
- Be prepared to explain what gene expression is and how it relates to cell function

Do Part A (15 minutes)

- Steps 1 and 2 show the sample genes you will look at, on chromosomes 2 & 11
- For Step 3, decide which person in your group of four will investigate each of the following cells: beta cell in pancreas, developing red blood cell, intestinal lining cell, or smooth muscle cell
- Review the table in Step 4
- Complete Part A


CELL TYPE:
beta cell in pancreas
red blood cell
intestinal lining cell
smooth muscle cell
GENE
chromosome 2
chromosome 2
chromosome 2
chromosome 2
ribosome protein
protein synthesis initiator
actin, smooth muscle type
cellular respiration enzyme
lactase
AGA enzyme
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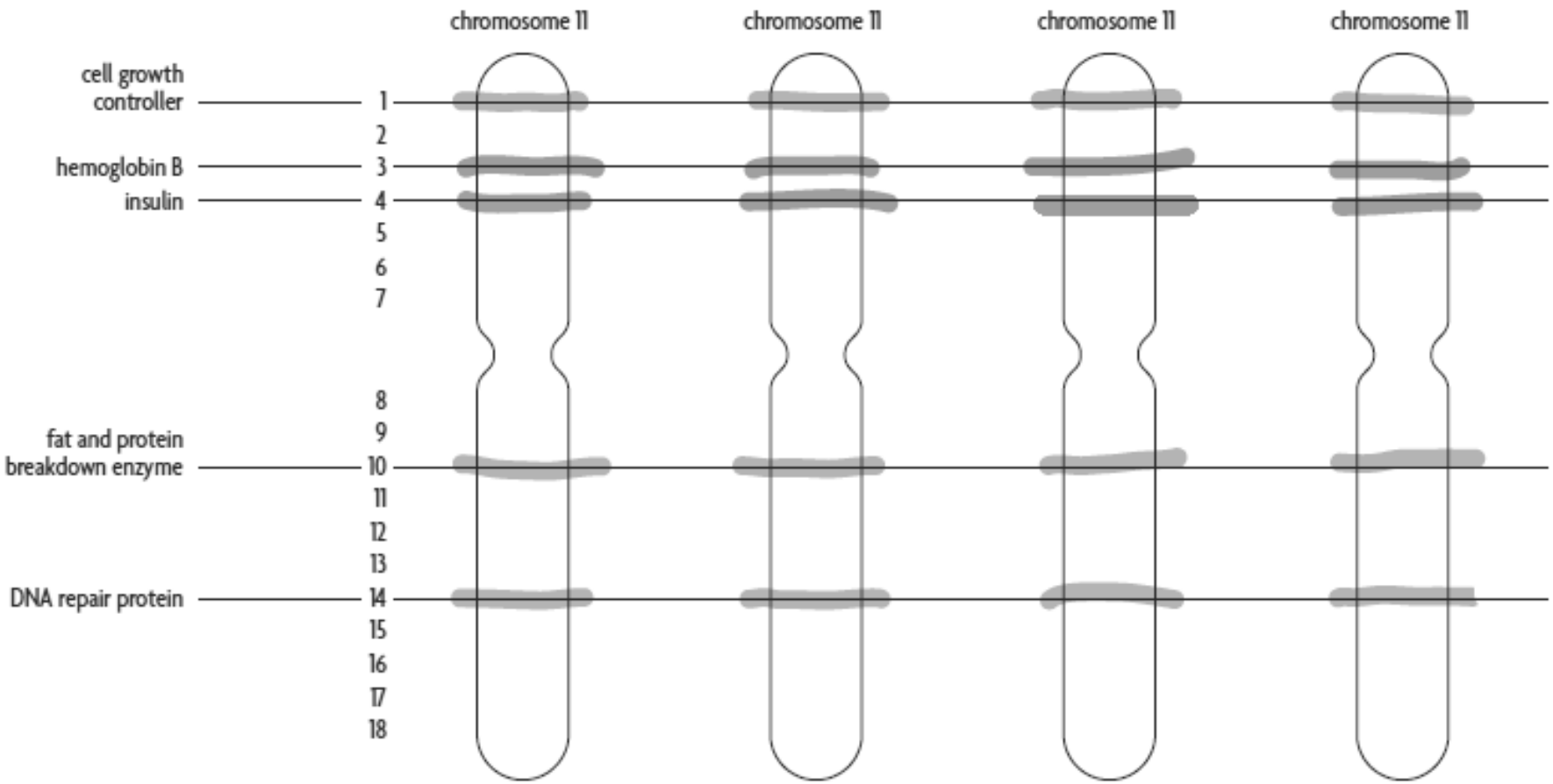
chromosome 11
chromosome 11
chromosome 11
chromosome 11
cell growth controller
hemoglobin B
insulin
fat and protein breakdown enzyme
DNA repair protein
1
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17
18

Discuss Part A (5 min)

In your group of four, discuss:

1. Which genes are active in all four cells? Why?
2. Which genes are only active in some of the four cells? Why?
3. Which protein isn't made in any of the four cells? Why?

Do Part B

Work with your group of four to:

- Conduct Steps 7–13 (15 minutes)--Note that if a card says to remove activators or repressors and there are none there, you don’t need to remove them
- Conduct Steps 14–16 (5–10 minutes)

Do Part C (25 minutes)

- Use the Read, Think, and Take Note strategy as you read the case study

Read, Think, and Take Note: Guidelines

As you read, from time to time, write one of the following on a sticky note:

- Explain a thought or reaction to something you read.
- Note something in the reading that is confusing or unfamiliar.
- List a word that you do not know.
- Describe a connection to something you learned or read previously.
- Make a statement about the reading.
- Pose a question about the reading.
- Draw a diagram or picture of an idea or connection.

Follow-up discussion (5 minutes)

- Part A: How does gene expression vary among different cell types?
- Part B: What kinds of changes in the organism or its environment lead to short-term changes in gene expression?
- Part C: How is gene regulation related to issues of sustainability and genetically modified organisms?

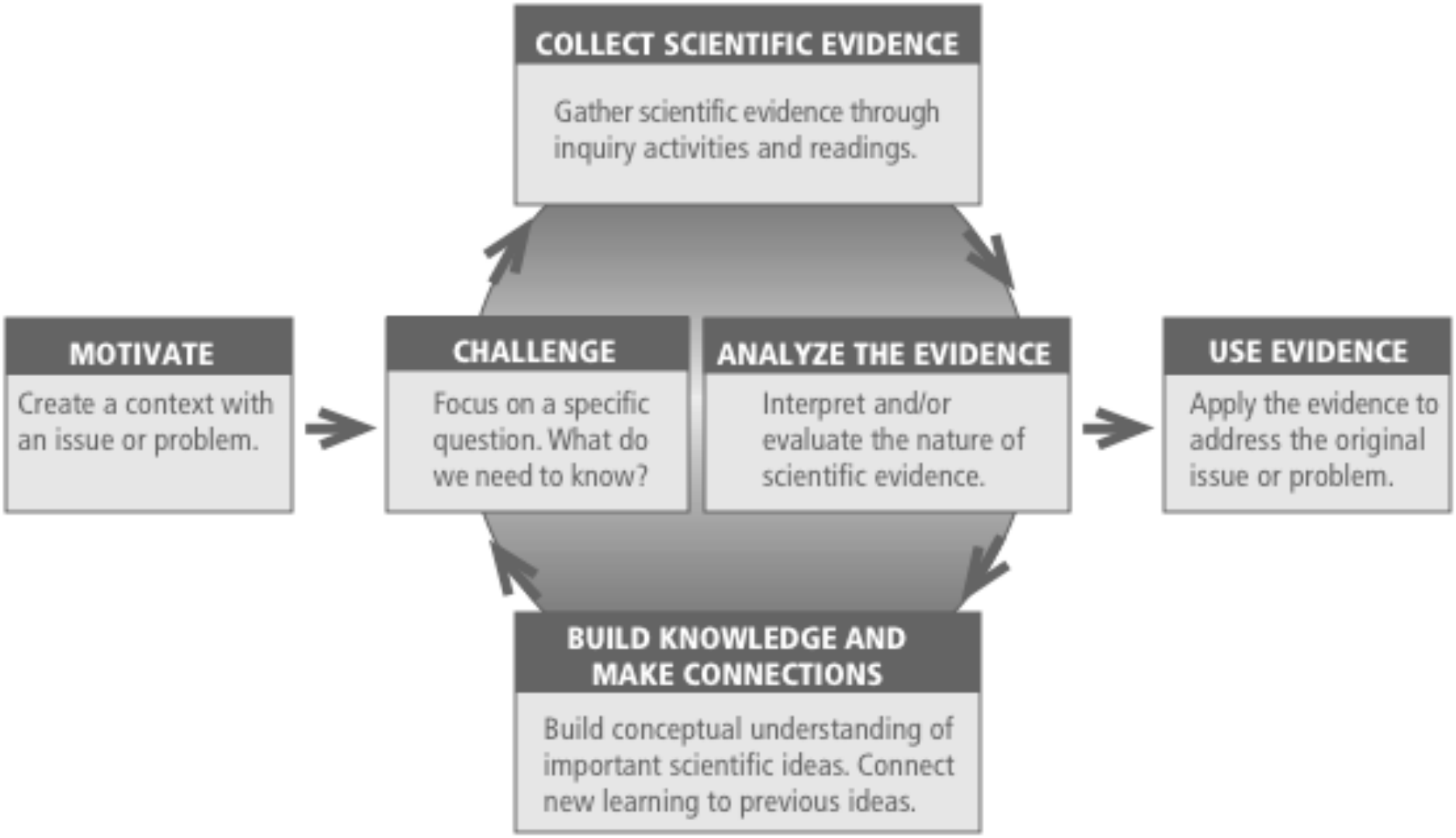
Revisit the Challenge

- How does the same set of genes direct the activities of 220 human cell types?

Genetics Topics

- Basic genetic concepts
  - Genotype and phenotype
  - Punnett squares
  - Mono- and dihybrid crosses
  - Genes, alleles, chromosomes & DNA
- Mendel's work
- Mechanisms of inheritance
- Selective breeding
- Mitosis and meiosis
- Genetic modification
- Gene expression
- DNA structure & replication
- Protein synthesis

SEPUP: Instructional Model for Issue-oriented Science



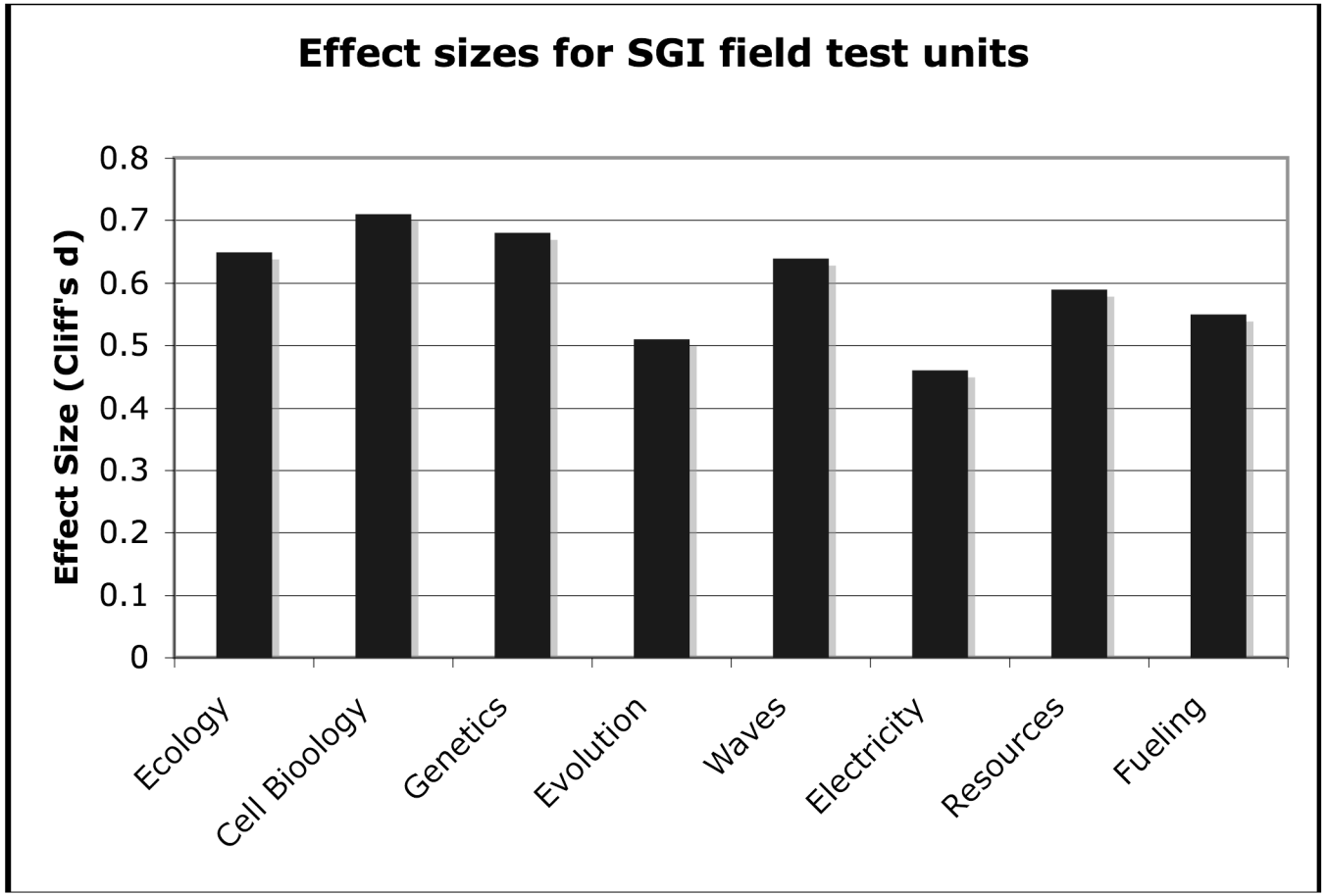
Why Issue-oriented Science?

- Integrates sciences & science with other subjects
- Realistic view of how science contributes to solving problems and the role of science in careers
- Real-world connections
- Use of science in daily life
- More authentic science, for ALL students
- Helps students learn science
- Improves student attitudes toward science

Development Process

- Iterative process of development, testing, expert review, evaluation, and revision developed and refined over 22 years of NSF funding
- Develop learning outcomes, assessments, and rough activities; pilot locally
- Refine activities and field-test nationwide; teachers receive PD; 1-2 cycles per unit
- Evaluate
  - Internal evaluation of usability for T and S
  - External evaluation of learning outcomes and pedagogy
  - External evaluation of scientific content

SGI Student Learning Results: Effect Size by Unit



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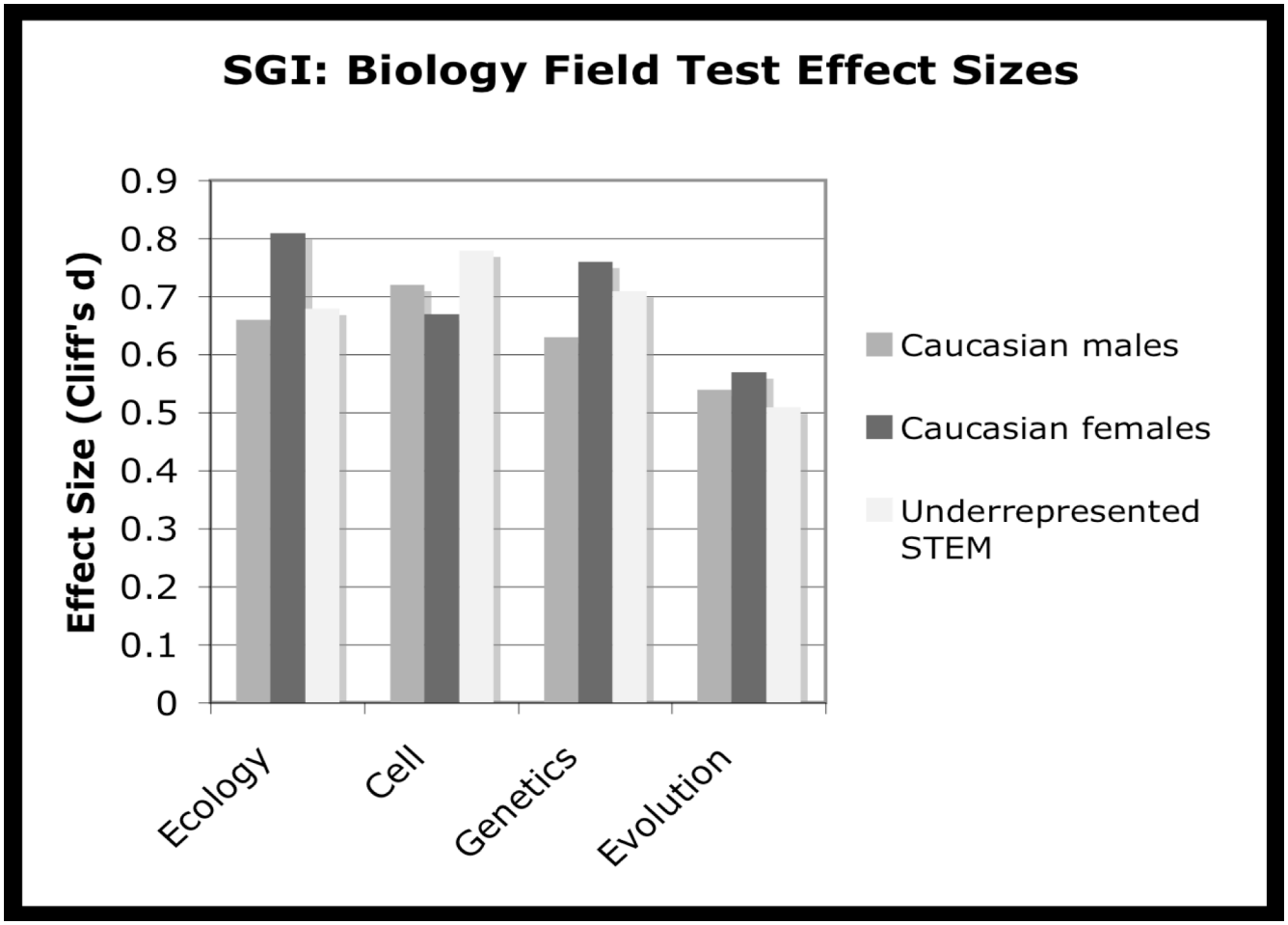
SGI: Biology Effect Size by Student Group



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SGI Addresses 21st Century Skills

- Digital-age Literacy
  - Scientific and informational literacy
- Inventive Thinking
  - Higher-order thinking, sound reasoning
- Effective Communication
  - Team work and collaboration
  - Personal, social, and civic responsibility
- High Productivity
  - Effective use of real-world tools
  - Ability to produce

Science and Global Issues: Biology

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www.lab-aids.com