Advancing Inclusive Research

Fact: people of color are vastly underrepresented in clinical research.[1]
This is not a new phenomenon—historical events like the Tuskegee Syphilis Study and the abuse of indigenous populations have led to a deep, pervasive mistrust of medicine among BIPOC communities. Health disparities also make it more difficult for members of historically underrepresented communities to access clinical trials. Only 5 to 15% of clinical trial participants are from communities of color.[2] The barriers are clear: the events of history combine with current socioeconomic disparities to make it exceedingly difficult for people of color to participate in clinical research.

Why is inclusive research important?
In order to know if a therapy works for all types of people, it must be tested on all types of people. Modern computing allows scientists to develop personalized treatments for patients. By testing trial participants who mirror those living with a specific condition, scientists can identify important biomarkers that serve as indicators of disease. However, these treatments can only be effective if they are built on a foundation of robust data. A lack of access to clinical trials means that communities of color miss out on potentially life-saving therapies when they need them the most.

How can the barriers to advancing inclusive research be overcome?
Genentech has committed to advancing inclusive research by forwarding the following large-scale initiatives[3]:

- **Diversifying clinical trial recruitment and site selection.** Genentech is working with community hospitals to meet patients where they are. Traditionally, clinical trials have taken place in large-scale research hospitals and patients had to take time off of work and pay for expensive travel arrangements. By localizing clinical trial research, a wider array of people can have access to potentially life-saving care.
- **Developing relationships with historically disenfranchised communities**. The process of building trust with members of marginalized communities is time-intensive and crucial work. By developing relationships with community leaders and organizers, Genentech can establish powerful alliances that help level the playing field when it comes to health disparities.
- **Enhancing personalized healthcare.** There is still so much more to learn about what makes each of us unique. The personalized medicine movement regards each patient as an individual with a distinct health journey. Genentech's push to learn about clinical outcomes in patients of color will result in a greater understanding of how and why treatments work differently in different bodies.

What does inclusive research look like in the future?
The spotlight that shone on the clinical trials for the Covid-19 vaccines brought urgency to the issue of underrepresentation in scientific research. In order for research to truly be inclusive, it must involve practitioners from historically marginalized communities. Representation allows future generations of students to envision themselves as leaders and serve as bridges that connect their communities to clinical research.

[1] *https://www.gene.com/stories/pursuing-a-new-paradigm-in-inclusive-research*
[2] *https://www.gene.com/stories/pursuing-a-new-paradigm-in-inclusive-research*
[3] *https://www.gene.com/patients/advancing-inclusive-research*

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Computational Thinking

In her 2006 essay entitled "Computational Thinking[1]," Carnegie Mellon Professor of Computer Science Jeanette Wing made the case that thinking like computers is a helpful tool for everyone, and not just computer scientists. As Wing stated, there are some things humans can do better than computers, but there are also some things computers do better than humans. Computational thinking allows humans to take the things computers do so well (such as collecting data and building models) and apply them to solving real-world problems.

Since Wing's essay was published, computational thinking has become a mainstay of modern K–12 education and can now be found in curricula across the world. While computational thinking is a philosophical approach based in computer science, it has applications for every discipline.

The following seven computational thinking strategies have been incorporated into this biotechnology curriculum:

1. **Collecting Data**
   What it is: Gathering the right information in order to solve a problem

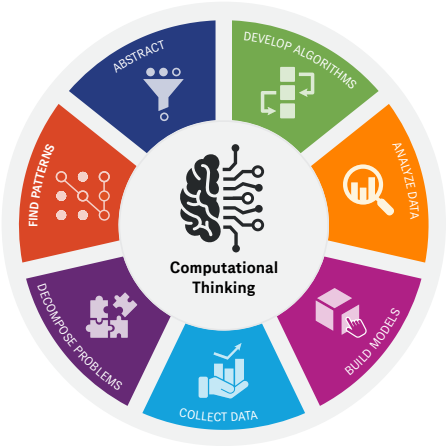
   How it's used: Designing experiments, conducting research, developing surveys, receiving feedback

2. **Analyzing Data**
   What it is: Identifying relationships within data; developing predictions based on data

   How it's used: Creating graphs, identifying reputable sources, manipulating data models

3. **Finding Patterns**
   What it is: Spotting themes and trends; determining cause and effect; sorting data with increasing refinement

   How it's used: Identifying examples of systemic inequality; drawing connections between changing environments and the evolution of species



4. **Decomposition**
   What it is: Breaking down a problem into more manageable sub-problems

   How it's used: Identifying phases in a process, such as mitosis or meiosis; pinpointing gene mutations within a larger DNA sequence

5. **Abstraction**
   What it is: Discarding irrelevant data and keeping only what's necessary in order to solve a problem; seeing the big picture

   How it's used: Understanding the basic principles behind gene editing; developing summaries and presentations; using graphic organizers and meaning-making tools like Venn Diagrams

6. **Developing Algorithms**
   What it is: Creating step-by-step instructions on how to conduct a process or complete a task

   How it's used: Explaining the processes of transcription and translation; developing public service announcements with specific calls to action

7. **Building Models**
   What it is: Testing a hypothesis; creating simulations; developing replicas

   How it's used: Creating 3D models of cell structures; conducting labs

[1] *https://www.cs.cmu.edu/~15110-s13/Wing06-ct.pdf*

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Culturally and Linguistically Responsive Instructional Strategies

The foundational strategies used for this text come primarily from the work of Sharroky Hollie, PhD, **Culturally and Linguistically Responsive Teaching and Learning:** *Classroom Practices for Student Success* (©2012 Shell Educational Publishing, Inc.) and from The Center For Culturally Responsive Teaching And Learning: Validate, Affirm, Build, and Bridge™ (*https://www.culturallyresponsive.org*).

Dr. Hollie and the Center call for instructional practices in a classroom environment to **validate** and **affirm** the diverse cultures present, **build** connections to the content, and to **bridge** the academic environment with the culture and language all students bring to the classroom.

Strategies from various educational and government sources, who adhere to the principles of culturally and linguistically responsive instruction were also included in the text.

The incorporation of such strategies provide for extremely successful classroom practices like **non-volunteerism**, to avoid unconscious bias when selecting students to respond, **peer feedbac**k, which allows for content scaffolding/support for culturally diverse students in their use of academic and scientific vocabulary; and the use of **partner work** and **small group activities** to allow for safe environments for students to express their ideas.

Examples include:

- *Numbered Heads Together*: Students are placed in groups of four to six and numbered. When asked a question, students work together to find the best answer. When called together again the teacher rolls a die and asks the student from the group with that number to stand. That student then represents the group and responds with the group's answer. The goal of the strategy is to encourage group consensus and to have each member be accountable for the information.
  —Sacramento City Unified School District—"Protocols for Culturally Responsive Learning and Increased Student Engagement."
- *Brainstorming*: This process is intended to stimulate the generation of ideas in a small group by reducing the level of risk involved with creativity. Participants are given a task or issue to consider and make suggestions or share ideas about it. No one is allowed to criticize or comment upon any of the ideas, because the emphasis is on creativity and generating a lot of ideas first.
  —Western Michigan University—"Small Group Discussion Protocols."
- *Tuning Protocol*: One or more students shares an artifact of work to be discussed, and the other students provide warm and cool feedback .
  —Harvard Graduate School of Education Teaching and Learning Lab discussion protocols.
- *3-2-1 Bridge*: This routine asks students to uncover their initial thoughts, ideas, questions and understandings about a topic and then to connect these to new thinking about the topic after they have received instruction or done research. Initial responses to the topic include 3 Thoughts / Ideas, 2 Questions, and 1 Metaphor / Simile. After instruction or research the new responses to the topic include 3 Thoughts / Ideas, 2 Questions, and 1 Metaphor / Simile. The bridge asks the question: Explain how the new responses connect to the initial response?
  —Harvard Project Zero Thinking Routines.

Social and Emotional Learning

Social and Emotional Learning competencies center on the key attitudes and skills necessary for understanding and managing emotions; listening, feeling, showing empathy for others, and on making thoughtful, responsible decisions. All schools should see themselves in a framework that advances educational equity and excellence. We have embedded and summarized *The Collaborative for Academic, Social, and Emotional Learning (CASEL)* core competencies and aligned them to the lessons. This allows students to develop positive attitudes and values toward themselves and others. This type of instructional framing helps advance social and emotional learning with equitable learning environments. Throughout the text, strategies and instructional activities are focused on the practice of the following competencies:

- **Self-Awareness:** Knowing what we are feeling in the moment; having a realistic assessment of our own abilities and a well-grounded sense of self-confidence.
- **Self-Management:** Handling our emotions so they facilitate rather than interfere with the task at hand; being conscientious and delaying gratification to pursue goals; persevering in the face of setbacks and frustrations.
- **Social Awareness:** Understanding what others are feeling; being able to take their perspective; appreciating and interacting positively with diverse groups.
- **Social Management:** Handling emotions in relationships effectively; establishing and maintaining healthy and rewarding relationships based on cooperation, resistance to inappropriate social pressure, negotiating solutions to conflict, and seeking help when needed.

Emerging research and case studies show evidence that CASEL's SEL framework for implementation promotes justice-oriented civic engagement, while advancing inclusive research and engaging students and teachers in courageous conversations around difficult topics. The text cites HBUC colleges and voices directly from the community instead of through others' interpreted narrative—stories that have built mistrust of the medical community (Tuskegee Syphilis study, HeLa cell line) and the health consequences of those attitudes. Examples of opportunities to practice social-emotional awareness and management throughout the text include, but are not limited to:

- **Group Work:** Students work in cooperative learning groups or partnerships and use gamification strategies, in many instances, which aids in building community and social management. Group work allows students to practice empathy and encourages them to appreciate and learn from diverse groups.
- **Research and Discussion:** Students practice self-management skills, like persevering in the face of setbacks and frustrations, while pursuing research on diseases. Some students will have had personal experience with disease and carry that experience with them into sensitive discussions. This requires all research and discussion participants to demonstrate empathy and practice social awareness.
- **Personal Choice in Projects:** When there is a personal connection to the research required to complete a project, students will develop an interest in and a sense of purpose for the work itself. They become invested stakeholders in the learning process. The social and emotional learning strategies throughout the text help students establish that personal connection. This requires the use of empathy for those suffering with the disease, as well as social awareness of the perspective of the target audience.

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Social and Emotional Learning

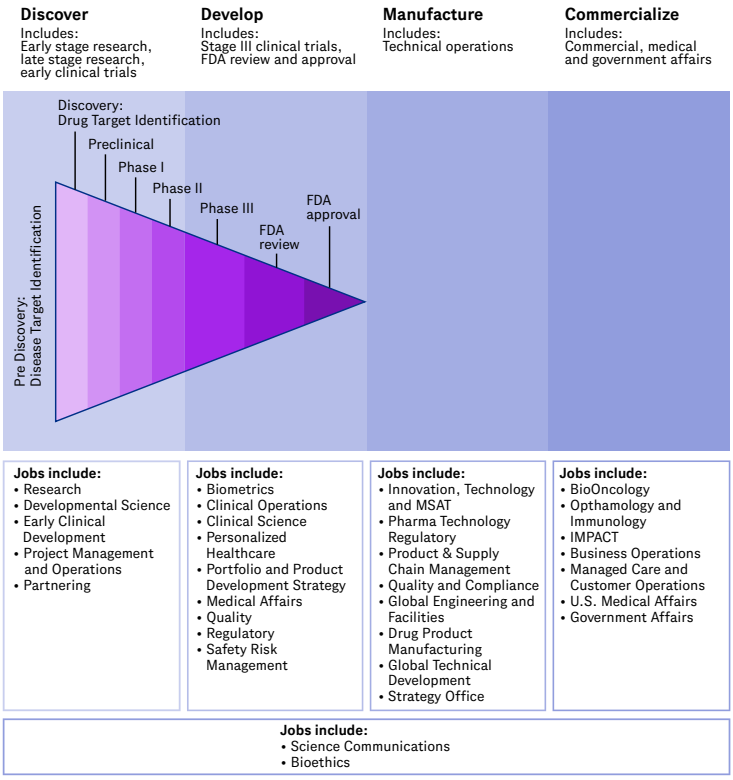
The development of a new therapeutic product (a new medicine or biologic) is a time-consuming, complex, and costly process. The overall purpose of the product life cycle of medicine is for researchers to discover whether or not a drug is safe and effective as a treatment for specific illnesses. It involves understanding the causes and patterns that contribute to the varied conditions of the disease and evaluating the impact of larger scale distribution. The product development life cycle consists of four main stages: Discover, Develop, Manufacture, and Commercialize. This process is vital to delivering safe and effective medical treatment.

Resources

- *Product Development Lifecycle*
- *How the Product Development Process Works in 7 Steps*
- *The Drug Development Process*
- *Drug Discovery and Development Process*
- *Vaccine Development—101*

Curriculum Connections

- **Discover:** Students research a vaccine-preventable illness and explore vaccine myths.
- **Develop:** Students outline the steps of the FDA review and approval process focusing on clinical operations, personalized healthcare, and safety risk management.
- **Manufacture:** Students explore drug product manufacturing focusing on product/supply chain management, technology/innovation, quality/compliance, and global production.
- **Commercialize:** Students develop social awareness campaigns for an infectious disease, addressing diverse audiences and emphasizing social justice in healthcare.

Industry & Career Connections

- **Discover:** Researcher, Developmental Scientist, Clinician, Project Manager, Biologist
- **Develop:** FDA Reviewer, Statistician, Toxicologist, Medical Technologist, Epidemiologist
- **Manufacture:** Pharmaceutical Engineer, Chemical Engineer, Material Scientist, Quality Control Inspector, Manufacturing Technician
- **Commercialize:** Product Development Manager, Customer Operations, Marketing Manager, Sales Executive, Digital Marketing Specialist