Biomaterials

with Dr Andrea S. Carlini

Talking *points*

Knowledge

1. What is a polymer?
2. What is oxidative stress?

Comprehension

3. Why is the team's structurally-responsive polymer able to monitor peroxynitrite for longer periods than small -molecule probes?
4. What are self-reporting materials, and why are they useful for monitoring disease?

Application

5. The team's structurally-responsive polymer undergoes an optical change when it binds to peroxynitrite, causing it to release a fluorescent dye. What equipment do you think they use to observe this change and track their polymer?
6. Andrea hopes to combine her team's smart biomaterials with wearable and implantable devices. How would you design a device that was comfortable, non-invasive and able to monitor disease?

Analysis

7. Andrea hopes that her team's smart biomaterials will enable doctors to receive real-time information about a patient's response to treatment. How would this improve the quality of healthcare a doctor can provide?
8. Emile says that, "Collaborations with other labs accelerate our progress." Why do you think collaboration is important in science?

Synthesis

9. Andrea's team hopes to create smart biomaterials that can deliver medicines as well as monitor disease biomarkers. How would you alter their structurally responsive polymer to enable it to deliver medicine to diseased parts of the body?

Evaluation

10. Andrea says that the next generation of biomaterials scientists will develop devices that help doctors provide individualised treatment to patients. How do you think individualised treatment would improve healthcare?
11. Andrea's high school calculus teacher once told her that, "Success is 10% smarts and 90% drive." To what extent do you agree with this statement, and why?

Activity

Andrea's research highlights how smart, structurally-responsive polymers can track biomarkers like peroxynitrite. By integrating these smart biomaterials with wearable and implantable devices, doctors could receive live digital data about how a patient is responding to treatment. However, deploying internal tracking sensors raises critical social, ethical and logistical questions.

Divide into two groups: Group 1 will argue that widespread adoption of this biotechnology (e.g., mandating implantable sensors, automating drug delivery and linking biological data to digital healthcare clouds) is the best way to eliminate disease. Group 2 will argue that strict regulatory protection and individual autonomy (e.g., keeping data local, maintaining strict opt-in laws and prioritising non-invasive medicine) offer the most responsible solution. Each group should come up with 3–5 key points supporting their position.

Group 1 (Technological Adoption): Research how continuous health monitoring can save lives by catching chronic illnesses before symptoms show. Consider how this technology could streamline hospital treatment and automate precise medicine delivery. Think about the public health benefits of large-scale, real-time health data networks.

Group 2 (Regulatory Protection): Investigate the ethical risks of internal sensors, such as digital privacy hacks, corporate misuse of biological data and the loss of medical consent. Think about the psychological impact of constant health monitoring and the potential for device malfunctions or misdiagnoses.

Present your arguments and respond to each other's points, challenging ideas and offering counterarguments. At the end of the discussion, reflect on what you learnt:

- How do self-reporting biomaterials illustrate the importance of balancing technological innovation with data privacy?
- How could tracking early warning signals like peroxynitrite shift our healthcare system from reactive treatment to proactive prevention?
- To what extent should funding prioritise internal biotech over improving equitable access to basic healthcare, and why?
- To what extent would you be comfortable hosting an internal sensor if it guaranteed early detection of serious illnesses, and why?

More *resources*

- Learn more about the research taking place in Andrea's Lab: **carlini-group.chem.ucsb.edu**
- Learn more about biomaterials by watching this video by CrashCourse: **youtube.com/watch?v=-jw8osY5QJM**