

The teachFASTly.com resources are not intended as a complete curriculum. The activities are designed to be woven into your existing teaching. This Quick Stop Lesson Plan is therefore not a single lesson plan, but rather a quick way of exploring the themes of an activity map. It includes one Discover activity, one Delve activity, and one Debrief activity. Together, these may take more than a class period, and you may want to add other activities between them. For more information visit www.teachfastly.com.

Motives, Virtues, and Science: The Story of DNA

Teaching the details of the discovery of DNA's structure provides an opportunity to integrate history, ethics, the nature of science, and discussions of what motivates people in science. Connecting this story to the larger question of how faith can relate to science offers space for exploring how the eyes of faith might see the range of motivations for doing science and the need for virtues in working collaboratively.

This activity map also offers opportunities to build cross-curricular connections between science class and Bible class, with activities that could be used in each. The cross-curricular approach engages students in model building, exploring the drama surrounding Watson and Crick's famous discovery, reflecting on ethical behavior, and making applications to their own motives for learning. The goal is to provide students with opportunities to reflect on the possibility of engaging in Christian practices when doing science.

It is recommended that work on this topic be coordinated between science and Bible teachers, and that good communication with parents be practiced.

This Quick Stop Lesson Plan on **Motives, Virtues, and Science** contains the following activities and attachments from www.teachfastly.com, which are combined for your ease of use in a downloadable ZIP file:

DISCOVER Activity: Science, Technology, and Motives

Activity Attachment

- *Identifying Assumptions Handout*

DELVE Activity: The DNA Drama

Activity Attachments

- *The Drama of DNA Handout*

DEBRIEF Activity: Why Do I Do Science?

Activity Attachment

- *Why Do Science Survey Handout*

DISCOVER

Activity: Science, Technology, and Motives

Time: 30 Minutes

In Brief

This activity introduces distinctions between basic science, applied science, and technology, and engages students in exploring how each of these relate to faith-informed motivations.

Goals

Students will understand the distinctions between basic science, applied science, and technology. Students will understand that each of these can be related to various faith-informed motives.

Thinking Ahead

Our often untested assumptions about the nature of science and technology and the behavior of scientists can have a strong influence on how we see the relationship between faith, science, and technology. This activity engages students in exploring how motives relate to different aspects of science and technology. It is intended as a vehicle for seeing possible connections and not for providing a set of fixed right answers. It can be used as an introduction to prepare for work on motives, character, and worldview in connection with the science of DNA. Consider whether any of the motives explored here are evident in your teaching practices.

Preparing the Activity

You will need: a set of activity cards, a set of motives cards, and copies of the categories sheet for each pair of students from the **Identifying Assumptions Handout**. It is helpful to print the activities cards and the motives cards on different colored paper.

Teaching the Activity

Explain to students that they are going to begin to think about the relationship of science and technology, and also about how faith can inform the motives of those who work in science or technology. If the concepts are new, first ask students what they think the difference is between basic science and applied science. Elicit that while both engage in research and develop models, basic science seeks to generate general explanations, models, theories, and predictions (such as how cells work), while applied science seeks to generate explanations, models, and predictions that help solve a specific applied problem (such as curing a disease). Then ask how these

two sciences are different from technology, and elicit that technology involves building solutions or products, often drawing on the findings of science, to meet particular goals (such as developing a marketable vaccine).

Ask students to work in pairs. Give each student a categories sheet and the two sets of cards provided in **Identifying Assumptions Handout**. Ask them to work first with the cards that list various kinds of science- and technology-related activities and to use the category sheet to sort them under Basic Science, Applied Science, or Technology.

Reference the grid below for expected answers found on the **Identifying Assumptions Handout**.

Researching the properties of electromagnetic waves: Basic Science	Investigating optimal materials for use as WiFi receivers: Applied Science	Designing more efficient wireless devices: Technology	Developing a model to explain why a disease spreads rapidly and predict how it might spread further: Applied Science
Developing a theoretical model of the structure of DNA: Basic Science	Building a nuclear power plant: Technology	Researching factors that could make nuclear power more efficient: Applied Science	Deriving three dimensional momentum conservation laws: Basic Science
Researching the effect of car mass on the damage sustained in a collision: Applied Science	Studying the relative effectiveness of alternate methods for slowing the progress of a disease: Technology	Developing a procedure fo genetic testing during pregnancy: Technology	Developing a car design that maximizes driver safety when the car crashes: Technology
Researching how different designs for aircraft wings affect fuel consumption: Applied Science	Studying rain forest plants to determine which of them have medicinal potential: Applied Science	Developing a procedure for extracting a medical ingredient from a rain forest plant. Technology	Developing a classification of rainforest plants: Basic Science

Circulate the classroom as students complete this exercise to look for common misunderstandings. After a brief discussion to review the results and check student comprehension, tell students that the second set of cards lists a number of motivations that Christians might have for investing time and effort in science or technology. Again in pairs, ask students to see whether any of these match best with basic science, applied science, or technology. Some will be easier to place than others. After allowing students to wrestle with this for a few minutes, point out that correct answers are less clear in this part of the essay, but ask what kinds of motivations fit best at the technology end of the continuum and which fit best at the basic science end.

In conclusion, ask students to reflect quietly for a moment on which of the motivations most strongly speak to them personally.

DELVE

Activity: The DNA Drama

Time: 90 Minutes

In Brief

This activity engages students in examining the history and drama surrounding DNA's discovery. It gives them the opportunity to analyze the motives of scientists, observe and critique good and not-so-good behavior, and observe and analyze scientific methodology. It engages students in seeing the history of science from multiple perspectives.

Goals

Students will learn about the story of the discovery of DNA's structure. Students will examine the story from the angles of methods, motivations, and morals and understand the relevance of each to scientific work.

Thinking Ahead

This activity involves showing a video that delves into the events that occurred during the discovery of DNA's structure. The activity can be preceded by a presentation on DNA's history before the events where the video starts. Part of the point of this activity is to present science as a human practice that is bound to human motivations, virtues, and vices. Consider whether students in your courses are taught science in a way that suggests that scientific results and theories simply appeared and had no history in human choices and responsibilities. Once we begin to see science as a practice involving people working together in concrete circumstances, and not just a methodology or a body of knowledge, it becomes easier to see how science is connected to our formation and to questions of how we treat one another and the world around us. Science is related in its practices to moral responsibility and, ultimately, to the faith that calls us to love our neighbor.

Preparing the Activity

You will need: the documentary film DNA: *The Secret of Life* (Full Title = DNA: *The Molecule of Life – Episode 1: The Secret of Life*, Directed by Ian Duncan and David Glover, Windfall Films Production, 2003); and copies of **The Drama of DNA Handout**. Copying each page on paper of a different color will be helpful. The film is widely available for download or streaming from the Internet, or in DVD format from your local library.

Teaching the Activity

Divide students into three groups. They do not necessarily need to sit by each other; you could simply number around the room. Distribute the appropriate question sheets

from **The Drama of DNA Handout** so that every student in each group has a copy of their group's sheet. Each student will receive their own sheet and make observations independently during the film. The questions given to each group of students focus on a different aspect of the film.

- Group 1 focuses on the motivations, reasons, and benefits of doing science for each of the main players in the DNA drama.
- Group 2 focuses on the ethics of the scientists' behavior during DNA discovery.
- Group 3 focuses on the methodologies used during DNA's discovery.

Give students a few moments to look over their task.

Play the **DNA: The Secret of Life** video (approx. 53 minutes). You may want to break this up over two days and provide time for students to ask questions at the halfway point.

The following details can be presented to students at the beginning or teased out through the film viewing:

- Watson sat in on Franklin's presentation and used that information to build a model with Crick. (Using research results that have not yet been published is not good scientific practice.)
- Crick and Watson used the results of Franklin's X-ray to figure out the structure of DNA.
- Franklin was never awarded a Nobel Prize because she died before it was given to Watson, Crick, and Wilkins and the award isn't given posthumously.
- Franklin never knew that Wilkins had shown Watson her X-ray picture which provided evidence for a double helix structure.
- Franklin was also responsible for providing evidence that the nucleotides were on the inside, not the outside.
- Franklin died of ovarian cancer, which ran in the family, and Crick and his wife spent a lot of time with her near her death.

When the video is finished, direct students from each group to meet and review their notes. If you copy each group's sheets on paper of a different color it makes it easy for group members to find each other. Allow students to write and rewrite their notes as they discuss each other's observations and think of new insights and missed information. Encourage them to come up with the most thorough report they can by collaborat-

ing and sharing findings within their group. Emphasize that each member of the group needs to end up with a thorough report on their own sheet, because they are going to be asked to share it further.

When they have finished discussing, re-form the students into new groups of three containing one student from each of the original groups. If you have used colored paper, each group should have one sheet of each color. Provide clean copies of the two handouts each student is missing. For example, a student originally from group 2 will need handouts 1 and 3. Provide each student enough time to explain and expound on their group topic while the other two take notes. When finished, each student should have full notes for all three situations.

Conclude with a brief class discussion of how methods, motives, and morals are all meaningful ways of looking at scientific work. Ask students to consider where faith might enter this picture.

Discuss the collaboration during the student exercise and why having different people focus on different things, and then share their findings, might be a valuable way to conduct inquiry. What does this gain over individual work? Did they find they had missed things noticed by others? Ask students to comment on what virtues are needed for the collaboration to work well. For example, each group needs to be diligent and honest. Trust in, and respect for, the work of others are needed.) Have students explicitly consider not only whether the collaboration led to good pragmatic outcomes, but also why it might be valuable in itself in terms of honoring other people.

Collect students' response sheets to assess understanding of the video. If you wish, have students write a brief reflection that considers the practical benefits and virtue aspects of collaborating with others, and how these could relate to scientific work.

DEBRIEF

Activity: Why Do I Do Science?

Time: 50 Minutes

In Brief

The Delve Activity: The DNA Drama focused on famous scientists' motivations for doing science. This activity turns attention to students' own thoughts, desires, and actions as they learn science. It engages students in reflecting on their motivations, how they are shaped, and how they connect to faith.

Goals

Students will examine their own motivations for learning science.

Students will show understanding of how faith can inform motivations for learning science.

Thinking Ahead

Previous activities have focused on how motivation and character relate to science. This activity connects these questions to students' own motivations, asking them to reflect on why they do science, what they'll use science for, and how they'll view science in their lives. Be sure to spend some time reflecting on the questions on the **Why Do Science Survey Handout** before discussing them with students. Note that the activity asks students to notice both that there can be explicitly faith-grounded reasons for engaging in scientific study, and that some broader reasons for studying science can be grounded in, or related to, faith also, even if not articulated in explicit faith language. This is because of science's connection with serving and seeking the wellbeing of others and of creation, with appreciating the wonder of creation, or with developing our gifts. Consider what is communicated through the way you practice and talk about science during your regular science teaching, and why students should take the work seriously. Is motivation framed mainly in terms of school requirements and deadlines, or is it regularly related to deeper human motivations for science?

Preparing the Activity

Needed: One copy of the **Why Do Science Survey Handout** for each student

Teaching the Activity

Explain to students that they are going to take a survey about their motivations for doing science. Make clear that the survey does not assume they love science, but instead asks them to think about why they put any effort into science class and what might make science learning seem personally worthwhile to them.

Hand out the survey found in **Why Do Science Survey Handout**. It lists various motivations for people to do science. Have students work individually to rank the items in terms of how much each motivation listed applies to their own motivation to do science work in school.

Arrange students into groups of three or four and have them exchange papers and view other group members' rankings. Have them discuss which person in the group they were most similar to, and what types of motivations were ranked high or low across the group. Discuss the findings as a class, and ask students why they think some motivations were ranked higher than others.

Have students answer the take-home reflection questions on the back of the handout for homework. They are:

- What reasons or motivations were new to you or something you had not thought of before?
- Can you think of other motivations or reasons that weren't listed among the ten examples? What are they?
- How do you think your own reasons or motivation could change or be changed?
- Look at the motivations you have ranked more highly? What character qualities do they imply, such as curiosity, care for the wellbeing of others, capacity for appreciation and wonder, discernment, desire to serve, ambition? Are these qualities you want to develop?
- One of the motivations listed mentions God. Which of the others could also be Christian reasons for studying science? How might they connect with faith?

Take time at the beginning of the next day's class to discuss students' answers to the reflection questions. By beginning with a chance for them to compare answers in small groups before the whole class discussion, you create a safer space for students to share their ideas, rather than asking for immediate sharing to the whole group. Collect students' written responses to assess students' ability to connect faith, motivations and science, especially in ways that move beyond the presence of explicit God language to more implicit faith motivations. Many of the motivations listed do not mention God but could be connected to faith. See whether students are able to make these connections.