

Instructor Guidance

Overview

Bionics, or bio-inspired engineering recognizes that nature has something to teach us. For billions of years, nature has successfully engineered natural, adaptive technologies for its survival. The organisms and ecosystems we are surrounded by face many of the same challenges that we do. Studying how nature has developed solutions for living organisms can be very effective in solving today’s engineering problems and has inspired human engineers to mimic many natural designs to solve complex problems and develop incredible technologies. Over the years, Festo has explored these principles of nature through its Bionic Learning Network. Our engineers take an innovative “bionic” approach, imitating elements of nature to seek solutions to the challenges facing our automated world. In the process, many samples of bionics-inspired projects have been developed, which the Bionic Learning Network’s team of engineers, designers, and biology experts realized could be used to inspire and engage learners in the subject of bionics. So, they created the Bionics4Education innovative learning platform and Bionics Kit, which together, offer students a fascinating, hands-on experience in the world of bionics as they complete similar bionic-inspired projects.

Three bionic robots...



The Bionics Kit contains the material to build three different bionic-inspired robots:

1. Bionic fish
2. Bionic elephant
3. Bionic chameleon

Content, including bionics concepts, project instructions, and career exploration, is available on the Bionics4Education website.



This comprehensive collection of information helps guide learners through their bionics experience while encouraging them to ask the right questions and look to the correct models in our environment to understand how living things meet specific functions.

For example, why are fish tails designed like they are? How



would nature pick up objects? How does an elephant control its trunk? How can we optimize the swimming ability of a fish?

All bionic robots are actuated by servo drives and controlled by a microcontroller. Detailed instructions allow students to create the robots and easily control them by using their smartphones, tablets, or computers.



Because all objects can be disassembled and reassembled, it is possible to create all three models one after another with one Bionics Kit.

The Bionics Kit contains¹:

- Material to build the three bionic robots
- 4 electronic servos
- Arduino-compatible microcontroller
- 3D printed Fin Ray Effect® parts

¹ Common items, e.g., a balloon and paper, are required. Use of these additional items promotes student creativity and resourcefulness.

Student Highlights:

- Explore bionics concepts
- Understand and apply the Fin Ray Effect®
- Demonstrate how to use microcontrollers
- Create three bionic- inspired models
- Control robots
- Discover technical innovations inspired by nature

Navigating Bionics4Education

Everything you need, from directions on assembling the bionic robots to discovering how nature inspires technical innovations, can be found by clicking a honeycomb. Each menu item contains different information (honeycombs):

- **Bionics4Education** – Learn about Festo’s Bionics4Education learning platform and how to implement it.
- **Bionic Robots** – Everything necessary for creating the bionic robots is found here.
- **Bionic Learning Network** – Be introduced to the Bionic Learning Network’s team of scientists and discover how they are inspired by nature to solve complex problems and develop incredible technologies!
- **Nature Knows Best** – Explore how nature has already solved many of the problems we deal with every day!
- **Career Exploration** – Discover the different careers in biotechnology and complete an interactive Career Guidance activity.
- **Downloads** – Contains assembly instructions and additional Bionics4Education information.
- **Shop** – Easily purchase the Bionics Kit electronically and have it shipped to your desired location.

The **Bionic Robots** menu provides honeycomb clusters specific to each bionic robot.

- **Getting Started** – Everything you need to begin assembling the bionic robot and the information required to get you on your way!
- **Biological Background** – Explore biological information specific to the natural role model for each bionic robot.
- **Project Management** – Discover how to successfully work on a team by thinking about team goals, the different tasks required to achieve goals, how tasks should be organized, and how a team should work together to accomplish these tasks.
- **Advanced Activities** – You created a bionic robot! Congratulations! Want to be challenged? Here you’ll be presented with tasks that are more advanced and may require additional parts, knowledge, information, and answers that you may have to search for on your own during your quest.

Honeycombs can be grouped together to create the desired learning experience within a given time frame.

Teachers, after-school program directors, youth group leaders, or anyone interested in what nature has to teach us can review the content provided by Festo on the bionics4education website and incorporate it into any learning environment. The Bionics4Education platform and the Bionics Kit can be used for both younger and older students. And since bionics serves as a link between biology and technology, the Bionics Kit is a perfect addition to any integrative STEM education program or initiative.

It is recommended that you review all resources, as well as become familiar with the equipment/items required to complete each bionics project to ensure success in any teaching scenario.

Ideas/Suggestions:

- For younger students, use the content and videos located in the **Biological Background** honeycombs to help explain biological role models and natural inspiration for technical applications. Assemble the robot (either prior to, or in front of, the class) and demonstrate each bionic robot. During the demonstration, encourage the class to think about what questions the engineers and designers asked prior to designing the bionic prototypes and why certain models in our environment achieve specific functions. Once students understand that nature helps to solve problems, view the videos of other technical innovations located in the **Nature Knows Best** section.
- For middle school and high school students, incorporate some, or all, of the information contained in the honeycombs. Use the Kit in coding classes and encourage students to create programs for the bionic robots using the Arduino IDE. For any manufacturing type classes, focus on how nature served as inspiration for solving problems in the manufacturing/automation industry. Explain the importance of innovative technologies and their use in Industry 4.0. The resources found in the **Bionic Learning Network** provide examples of how engineers use the engineering design process and how they collaborate as a team.

Note: When creating the bionic robots, students can work alone or in teams. Step-by-step instructions are provided in pdf format. These instructions are located in the Getting Started honeycomb for each bionic robot and also in the download section.