Dr. HEARTBEAT

A LEGOLAND® California
Educational Resource Guide
Grades 3-6

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Welcome to LEGOLAND California Resort!

The Education Program Dr. Heartbeat was developed by LEGO® Education and LEGOLAND California Education. Teachers must be present during the program. For information on educational programs, visit **www.LEGOLAND.com/edu**

Arrival Please arrive at the front gate of LEGOLAND 30 minutes before your scheduled program. Students will put on lab coats to begin their ultimate lab experience!

Extended Learning: Recommended Rides and Attractions enhance the educational experience and provide applied learning. Worksheets are provided.

Lunches School groups may bring lunches in disposable containers and use self-storage bins. Lunches may be pre-ordered when you book your program, or purchased at LEGOLAND restaurants.

Safety LEGOLAND Parks are built to the highest standards of quality and safety. Height restrictions apply on selected attractions throughout the park.

Background Information

Learn about the human heartbeat!

The Circulatory System

The **heart** is the main organ in the circulatory system.

The circulatory system is made of the heart, blood, and blood vessels.

- The **heart** is a pump that moves blood through the body.
- **Blood** carries oxygen and nutrients (food) to all the cells of the body, and carries waste back from the cells.
- **Blood vessels** are tubes that carry blood throughout the body. The tubes are called arteries, veins, and capillaries.

Internal View of the Heart

The Human Heart

The human heart weighs less than one pound, and is about the size of two clenched fists. The heart has four chambers—the left ventricle and left atrium, and the right ventricle and right atrium.

Blood is pumped from lungs to heart, from heart to body, from body back to heart, from heart back to lungs. Here's how it works….

The Heartbeat

Breathe in! As you breathe, the lungs fill with oxygen that passes into the blood in the lungs.

Oxygen-filled blood from the lungs flows into the left chambers of the heart.

The left chambers of the heart pump oxygen-filled blood into the body through arteries. Arteries carry fresh oxygenated blood throughout the body. Oxygen passes into every organ, tissue, and cell in the body. Blood flows into the veins.

Veins send blood to the right chambers of the heart. This blood has no oxygen.

The right chambers of the heart pump blood into the lungs, to get fresh oxygen.
This cycle repeats with every heartbeat. Every heartbeat is one pump of the blood through the heart's chambers.

More Facts about the Heart

- On average, 1,000,000 barrels of blood is pumped through the heart in a lifetime.
- The heart beats about 35,000,000 times in one year.
- The heart beats about 100,000 times a day.
- The sound of a heartbeat is created by the closing of the heart valves.

Before and After the Visit: Research and Action!

Doctors Use Robots in Human Surgery

The System is called "da Vinci" in part "because Leonardo da Vinci invented the first robot, and he was very accurate in his drawings of the human body, using 3-D details to bring his works to life

The da Vinci System allows doctors to perform surgery through robotic arms. It is made up of

- A surgeon's "desk" in the same room as the patient
- A cart at the patient's side with four robotic arms controlled from the surgeon's desk.

Three robotic arms hold the tools, such as a scalpel or scissors. The fourth arm holds a special, high-resolution "endoscopic" camera that allows the surgeon to see inside the patient's body!

The surgeon sits at the console and looks through two eye holes at a 3-D image, while maneuvering the arms with two foot pedals and two hand controllers.

The da Vinci System translates the surgeon's hand movements into more precise micro-movements. The instruments operate through small incisions in the patient's body.

To perform a surgery, the surgeon uses master controls to maneuver the robotic arms. To help the surgeon with accuracy and precision, instruments are designed to twist farther than the human hand. Also, the surgeon's hand motion is scaled down to tiny micro-movements, and there is less tremor, or shaking, than a human hand.

The da Vinci System uses many safety features to detect human error. The surgical robot is never in control and is not autonomous; it operates only as the surgeon directs it, moment by moment.

The da Vinci System improves on procedures like laparoscopy—where surgeons also use a camera for surgery in the abdominal area. With the old technique, the surgeon stands up using long instruments that have no "wrists." The surgeon has to look away from the patient at a 2D monitor, and needs an assistant to position the camera just right. The da Vinci System allows the surgeon to sit with eyes and hands in line with the instruments, and the surgeon controls the camera.

The da Vinci System is designed to give surgeons better visualization, flexible movements, and precision. For the patient, a da Vinci procedure can offer less pain, less blood loss and less need for blood transfusions. It can mean a shorter hospital stay, a quicker recovery and faster return to normal daily activities.

Tri City Medical Center in Oceanside, California, started using the da Vinci system for surgeries in August, 2011. Check out www.tricitymed.org/robot for more information on this system in action!

Discovery and Learning

Applied Robotics at LEGOLAND® California

Knights' Tournament

Choose the power of your ride!
Robotic arms are programmed for five levels of power.
Within each power level, random combinations of movements make each ride a unique experience.

Knights' Tournament was created with the KUKA robot, originally built for industrial use.

KUKA Robotics is a worldwide leader in producing and installing industrial robots around the world. Their robots help manufacture cars, build bridges, and move pallets of food. KUKA robots operate as painters in explosive atmospheres, and heat resistant robots act as welders in a foundry (steel mill). KUKA industrial robots are used in production by GM, Chrysler, Ford, Porsche, BMW, Audi, Mercedes-Benz, Volkswagen, Ferrari, Harley-Davidson, Boeing, IKEA, Wal-Mart, Coca-Cola, and others. All are controlled from a common PC-based controller platform.

KUKA Robots have also appeared in Hollywood Films. In the Ron Howard-directed film, The *Da Vinci Code*, a KUKA robot hands Tom Hanks' character Robert Langdon a container containing a cryptex.

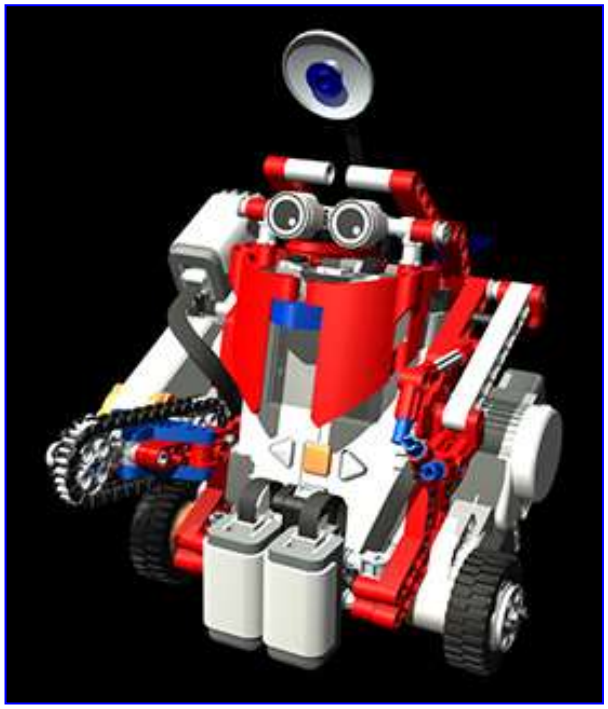
KUKA developed the first passenger-carrying industrial robot, the Robocoaster—which LEGOLAND guests can experience on Knights' Tournament! Roller-coaster-style seats attached to robotic arms. Riders themselves program the motions of their ride, and experience a roller coaster-like motion sequence. Try it!

Photos below show KUKA robots cutting steel for bridges (left), and moving pallets of food for a bakery.

Hands-On Activities

Dr. Heartbeat

Join Dr. Heartbeat and the LEGO® MINDSTORMS™ NXT Nano-Bots! Complete life-saving missions like removing bad veins and dangerous cells, deliver anesthetics, and more!



Put on your interns' lab coats to enter Dr. Heartbeat's lab in the Imagination Zone.

Dr. Heartbeat introduces the group to the microsurgical tasks that they need to complete. Students work in pairs with a robot, attachments, and computer loaded with Dr. Heartbeat's surgical software.

Each pair plans a strategy to complete robotic tasks needed to save patients' lives. Keep the LEGO® heart beating!

Students use the icon-based program to set up their robot's actions, then test it on the "operating" table.

Students modify their program based on the results, until they successfully complete one or more missions. They have a chance to demonstrate their strategy to the group.

About Dr. Heartbeat

Learning Outcomes

- Interpret diagrams to build robot attachments.
- Develop a strategy to complete tasks through an autonomous robot.
- Program a robot to accurately perform tasks such as retrieval, delivery, target-hitting, and other simulated microsurgical tasks.
- Explain strategy and evaluate effectiveness.
- Use Background Info to discover how robots are used in surgery.
- Discover real life robotics applications on LEGOLAND® rides and attractions.

California Next Generation Science Standards

GRADE 3-5 Engineering Design

3-5-ETS1-1 Define a simple design problem…that includes criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2 Generate and compare multiple possible solutions…based on how well each is likely to meet the criteria….
3-5-ETS1-3 Plan and carry out fair tests…to identify aspects of a model or prototype that can be improved.

GRADE 4 Energy

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

GRADE 4 Waves and their Applications in Technologies for Information Transfer

4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.

GRADE 6 Engineering Design

MS-ETS1-1 Define criteria & constraints of a design problem…to ensure a successful solution, taking into account relevant scientific principles….
MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria/constraints of the problem.
MS-ETS1-3 Analyze data from tests…to ID the best characteristics of each (design solution) that can be combined…to…meet criteria for success.

The performance expectations above were developed using NRC Framework for K-12 Science Education:

Science and Engineering Practices

Asking Questions and Defining Problems

- Define a simple problem that can be solved thru development of 1) A new/improved object… & includes…criteria for success….(3-5-ETS1-1) (or) 2) An object, tool, process …& includes multiple criteria/constraints, including scientific knowledge that may limit possible solutions.(MS-ETS1-1)

Planning and Carrying Out Investigations

- Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (4-PS3-2),

Construct Explanations and Design Solutions

- Generate & compare solutions…based on how well they meet criteria and constraints of the design solution. (3-5-ETS1-2), (4-PS4-3)

Disciplinary Core Ideas

ETS1.A Defining and Delimiting Engineering Problems

- …Different…solutions can be compared on the basis of how well each one meets the criteria for success…. (3-5-ETS1-1)

ETS1.B Develop Possible Solutions

- …Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- Communicating with peers about proposed solutions…can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify…difficulties, which suggest elements…that need to be improved. (3-5-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4)

ETS1.C Optimizing the Design Solution

- (Test) different solutions to determine which best solves the problem, given the criteria and constraints. (3-5-ETS1-3)
- Different solutions need to be tested to determine which best solves the problem, given the criteria and constraints. *(secondary to 4-PS4-3)*
- …ID'ing characteristics of the design that performed the best…can provide useful information for redesign….(MS-ETS1-3)
- …(T)esting the most promising solutions and modifying…on the basis of test results leads…ultimately to an optimal solution. (MS-ETS1-4)

PS3.A Definitions of Energy

- Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2)

PS3.B Conservation of Energy and Energy Transfer

- Energy can also be transferred from place to place by electric currents…to produce motion, sound, heat, or light. (4-PS3-2)

PS4.C Information Technologies and Instrumentation Digitized information transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information….(4-PS4-3)

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects. (4-PS3-2)

Interdependence of Science, Engineering, and Technology

- Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)

Influence of Engineering, Technology, and Science on Society and the Natural World

- People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase benefits, decrease risks, & meet societal demands. (3-5-ETS-2)

Common Core State Standards Connections K-2 and Grades 3-5

ELA/Literacy –

SL.3.3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. (3-PS2-3)
RI.5.7 Draw on information from multiple print or digital sources…to locate an answer…quickly or solve a problem efficiently. (3-5-ETS2)
RST.6-8.7 Integrate quantitative/technical info expressed in words in a text with a version…expressed visually…in a diagram or model…. (MS-ETS1-3)

Mathematics –

MP.2 Reason abstractly and quantitatively. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
MP.5 Use appropriate tools strategically. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)