LESSON 4 Changing Islands

Lesson at a Glance

Students examine and discuss forces of nature that lead to the slow or fast changes to an island. Students then focus on how coral reefs play a part in island formation. They view a PowerPoint presentation describing environmental factors necessary to promote the healthy growth and development of a coral reef, and how, eventually, an atoll, barrier reef, and fringing reef are formed. Students play a game to help them understand how fragile coral reef development is.

Lesson Duration

Two 45-minute periods

Essential Question(s)

How do forces of nature act to change islands over time?
How do coral reefs form?
How do coral reefs play a role in shaping the features of the Hawaiian Islands?

Key Concepts

- Slow processes of crustal plate movement carries older islands away from the hot spot, and plate tectonics provide an explanation for crustal movement.
- As a volcanic island is moved away from the hot spot, it progresses through a series of stages, including erosion and reef growth and, sometimes, rejuvenation of volcanic activity.
- Subsidence (sinking) combined with the erosive forces of rain, wind, and wave action transform volcanic islands into atolls.
- In the Hawaiian archipelago, coral reefs build up around the perimeter of islands, and contribute to the changing of features of an island.

Instructional Objectives

- I *can* describe fast processes in nature and explain how these act to change an island.
- I *can* describe how slow processes have shaped and reshaped the Hawaiian archipelago.
- I *can* collect and analyze data in an activity about coral reef formations.

Related HCPSIII Benchmark(s):

Science SC.4.8.1
Describe how slow processes sometimes shape and reshape the surface of the Earth.

Science SC. 4.8.2
Describe how fast processes sometimes shape and reshape the surface of the Earth.

Mathematics MA.4.1.3
Identify equivalent forms of commonly used fractions and decimals

Mathematics MA.4.11.1
Pose questions, collect data using observations and experiments, and organize the data into tables or graphs.

Mathematics MA.4.13.1
Propose and justify conclusions/predictions based on data.

Assessment Tools

Benchmark Rubric:

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.1		Describe how slow processes sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how slow processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to slow processes	Provide examples of the shaping and reshaping of the Earth's land surface due to slow processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to slow processes

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.2		Describe how fast processes (e.g., volcanoes, Earthquakes) sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how fast processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to fast processes	Provide examples of the shaping and reshaping of the Earth's land surface due to fast processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to fast processes

Topic		Numbers and Number Systems	
Benchmark MA.4.1.3		Identify equivalent forms of commonly used fractions and decimals	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Consistently identify equivalent forms of commonly used fractions and decimals	Usually identify equivalent forms of commonly used fractions and decimals	Sometimes identify equivalent forms of commonly used fractions and decimals	Rarely identify equivalent forms of commonly used fractions and decimals
Topic		Data Collection and Representation	
Benchmark MA.4.11.1		Pose questions, collect data using observations and experiments, and organize the data into tables or graphs	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Pose questions, collect data using observations and experiments, and organize the data into tables or graphs, with accuracy	Pose questions, collect data using observations and experiments, and organize the data into tables or graphs, with no significant errors	Pose questions, collect data using observations and experiments, and organize the data into tables or graphs, with a few significant errors	Pose questions, collect data using observations and experiments, and organize the data into tables or graphs, with many significant errors

Topic		Predictions and Inferences	
Benchmark MA.4.13.1		Propose and justify conclusions/predictions based on data	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Propose and effectively justify conclusions or predictions based on data	Propose and sufficiently justify conclusions or predictions based on data	Propose and justify, in minimal detail, conclusions or predictions based on data	Propose implausible conclusions or predictions based on data

Assessment/Evidence Pieces

Lesson

- *Processes or Events of the Earth* student worksheet
- *Atmosphere and What Have I Learned* student worksheet

Unit

- The Island Formations portfolio may be used to monitor student progress throughout the unit.

Materials Needed

Teacher	Class	Group	Student (Optional)
• Computer with hookup to TV or projector for video animation clips • Chart paper	• Animations	• 50 Pennies or counting chips • Poster board • Markers, crayons	• Shoebox or a similar kind of open ended box. • Construction paper of various colors • Scissors • Glue • String • Materials for Illustration

Instructional Resources

Student Worksheet: *Processes or Events of the Earth and Atmosphere*
Teacher Answer Key: *Processes or Events of the Earth and Atmosphere*
Student Reading: *Coral Reefs and Island Formation Note Taking Sheet*
Student Worksheet: *Coral Formation Game Results*
Student Worksheet*: What Have I Learned?*
PowerPoint Presentaion: *Coral Reefs and Island Formation*

Student Vocabulary Words

absolute location: the exact location on the planet where something resides, or the latitude and longitude of a place.
archipelago: a group of islands in an expanse of water, with many scattered islands.
atoll: a ring-shaped coral reef or string of closely spaced small coral islands that enclose or nearly enclose a shallow lagoon.
convergent boundary: two tectonic plates collide and one is pushed under the other plate.
divergent boundary: two tectonic plates that are moving away from each other.
fringing reefs: a reef that runs parallel to and is in close proximity or is directly adjacent to the shoreline.
guyot: a submerged seamount that at one time was above or in close proximity to the sea surface.

hotspot: generally localized plumes of magma that originate in the Earth's mantle and move outward through the crust; magma movement may result in volcanic eruptions.
high islands: islands that are composed of volcanic rock whose landmass is above the sea surface.
low islands: islands that are composed of coral and/or sand whose landmass is above the sea surface.
lines of latitude: numerical system of imaginary circles on Earth's surface that lie parallel to the Equator and are used to describe position north and south of the Equator; measured in increasing degrees north and south away from the Equator.
lines of longitude: numerical system of imaginary half circles on Earth's surface that lie perpendicular to the Equator and end at the poles, used to describe position east and west, measured in degrees with 0° at the Prime Meridian.
planula: free-swimming young stage coral.
plate tectonics: geologic theory that combines the concepts of sea floor spreading and continental drift to explain the large-scale movement of the Earth's crust.
relative location: the location of a place in relation to another place (Kauai is WNW of Oahu).
transform boundary: tectonic plates slide and grind against each other.

Lesson Plan

Lesson Preparation

- Review the Science Background provided in the Unit Overview.
- Preview the animations and make arrangements to project them.
- Review and make copies of Student Reading *Coral Reefs and Island Formation Note Taking Sheet* and Student Worksheets *Processes or Events of the Earth and Atmosphere*, *Coral Formation Game Results,* and *What Have I Learned?*, one per student.
- Assemble two pieces of chart paper: one for brainstorming lists, and the other a T-chart labeled *fast processes* and *slow processes*.
- Locate and preview the interactive animation module provided with this lesson.

I. *Geological and Meteorological Events that Reshape an Island*

A. Ask students to brainstorm ways in which an island may change after it is formed. List their ideas on chart paper or the board. (For example: Earthquakes, landslides, hurricanes, wind, waves, floods, other volcanic activities, coral reef formation/destruction, sinking, climate changes.)

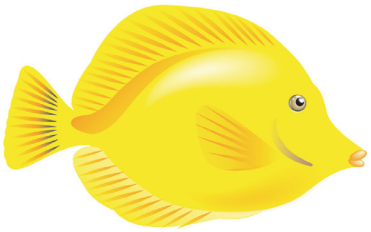
B. Circle geological events pertaining to the Earth (i.e., Earthquakes, landslides, volcanic activities) in one color, and meteorological events that pertain to the atmosphere (i.e., wind, wave, flooding, and climate changes) in a different color. Explain to the class that geologic and meteorological processes like the examples on the board occur at different rates. They can either be a fast process that happens quickly or a slow process that can take thousands or even millions of years.

C. Have students view animations of different geological processes. Show the following animations from the website: (to save time you may want to assign a video clip to small groups and have them report back their findings) http://www2.wwnorton.com/college/geo/egeo/index/animations.htm

1) Have students view the following from the Norton Website:
   a. Essentials of Geology: an Introduction to Planet Earth:
      (a) Chapter 2**:** (2.5) Seafloor spreading, (2.7) Formation of ocean crust, (2.10) Hot spot volcanoes, (2.11) The process of rifting.
      (b) Chapter 5. A surface veneer: (5.2) Transgression and regression.
      (c) Chapter 8. Earthquakes: (8.2) Seismic wave motion.
      (d) Chapter 10. How old is old? (10.1) Geologic History, (10.2) Types of unconformity.

D. After viewing the animations, assign each student a slow process or a fast process, but do not tell them the type of geologic process. Draw a line either on the board or place a piece of masking tape across the floor. Explain to students that they are to move to a place along the line of the continuum based on what type of process they *think* they were assigned, one end being *fast changes* to the island, and one end being *slow changes* to the island. Once they have moved to their spot on the continuum, allow for 2–3 minutes of partner talk time where students discuss what process they were assigned and why they feel it is a fast or slow process. Ask volunteers from each end of the continuum to share their thoughts on their geological process and its type. For those who share, clarify the process and its type for the class. Send students back to their seats.

E. Using a T-chart, decide whether each process students were assigned falls under the heading: *Fast Process,* or *Slow Process* in the building up, reshaping, and erosion of an island.
Following is a sample T-chart:



Fast Processes	**Slow processes**
Earthquakes	Continental drift
Landslides	Formation of ocean crust
Erosion/weathering	Reduction
Tsunami	Subsidence (sinking of a portion of Earth's crust)
Wind/waves	Seafloor spreading
Flooding	Erosion/weathering
Volcanic activity	Wind/waves

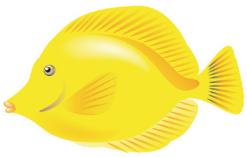
F. Check for understanding by having the class complete the Student Worksheet *Processes or Events of the Earth and Atmosphere*. Have the students fill out the worksheet and collect as the formative assessment.

II. *Coral Reef Formation*

A. Students will begin the portion of the lesson that should ultimately teach them that coral reef formation is another aspect of island formation. Give them a bridging statement, perhaps post in the classroom that we will now focus on a process that can be both fast and slow, and is immediately relevant to Hawai'i *Coral Reef Formation*.

B. Show PowerPoint *Coral Reefs and Island Formation.* As the students view the PowerPoint have them take notes on the Student Reading page *Coral Reefs and Island Formation Note Taking Sheet***.** For additional information on Island Formation and erosion watch the interactive module provided with this lesson.

C. Engage students in the *Survival Challenges for Coral Reef Formation Game***.** Divide students into groups of 4–5 students, and distribute a piece of poster, or large piece of butcher paper, to each group. Put the instructions below up on the board for students to refer to as they create their poster. Challenge students to design a seafloor that has the following sites and conditions:
   1) Create 2 strong current areas. (*Planula cannot attach.*)
   2) Create 2 dark areas. (*Reef building coral needs sunlight for growth.*)
   3) Create 2 areas full of mature coral. (*Planula doesn't have room to settle and grow.*)
   4) Create 2 areas with thick sediment on the seafloor. (*Planula cannot attach and grow here-Wow it's slippery!*)

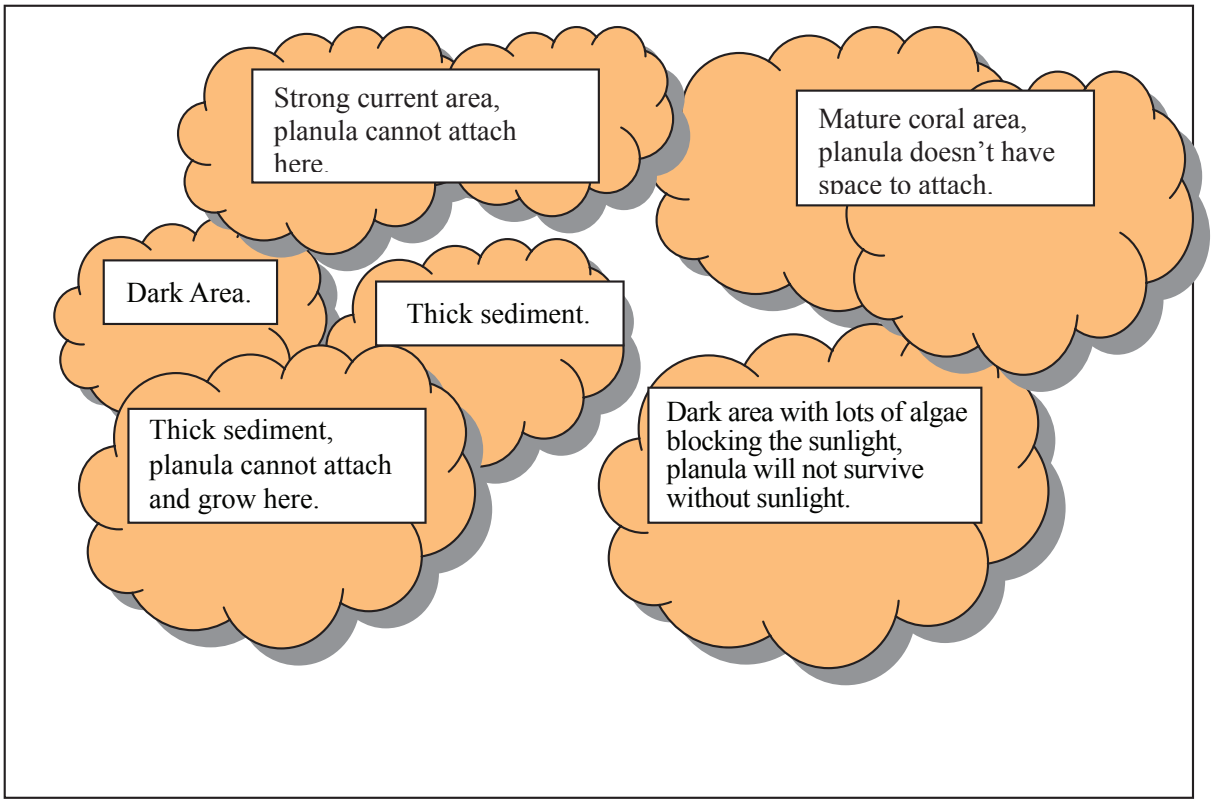


D. Explain to students that all other areas on the poster represent ideal areas for planula to attach and grow. This means that there are few environmental changes throughout the year, and no real seasonal changes in sunlight, ocean water temperature, or surface nutrients. There is almost always plenty of sun, warm sea surface temperatures, and few surface nutrients in the ocean water. (*Clear sunny water forming a healthy coral reef.*)
The following diagram helps explain a potential poster layout:

E. After designing their ocean floor, students will take their 50 *planula* (pennies, counting chips, or some other marker). Standing a challenging distance from the poster, they will have ***10 seconds*** to toss their planula onto the seafloor. Any planula not tossed within 10 seconds *dies*.

F. Students work as a group to count and record the number of planula that lived and were able to attach to the seafloor and begin forming a coral reef. Distribute one Student Worksheet to each group.

G. Have students record their results in a fraction and then a percentage, as for example**:**



10/50 = 1/5 = 20%. Repeat the process several times, recording the results each time.

H. Facilitate a class discussion to reflect on the groups' results. Ask and discuss the following questions:
   1) What percentage of the planula larvae survived the settling and successfully attached? (Note: you may need to help the students make the connection between the number of planula that attach and the number that actually survive.)
   2) What are some of the environmental factors that contribute to the successful settling of the planula? (Answer: There are few environmental changes throughout the year, and no real seasonal changes in sunlight, ocean water temperature, or surface nutrients.)
   3) Do you think coral reef formation is a fast or slow process? Why? (Answer: Coral polyp life is fast while the total fringe reef or atoll reef is slow.)
   4) Why is it important to understand fast and slow processes?

Extended Activity

Coral Reef Diorama

Note: This activity is meant for students who already have a background in corals and coral reefs.

If you choose to do this activity, it will fulfill Science Benchmark 4.3.2

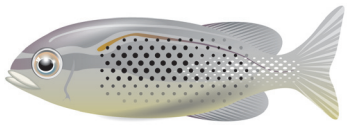
Criteria	Advanced	Proficient	Partially Proficient	Novice
SC.4.3.2 Describe how an organism's behavior is determined by its environment.	Explain and give examples of how different organisms' behaviors are determined by their environments.	Describe how an organism's behavior is determined by its environment.	Identify a way that an organism's behavior is influenced by its environment.	Recognize that an organism's behavior is influenced by its environment.

1) Review information about coral reefs.
   a.) Identify the different types of coral in Hawaiian waters (at least six types).
   b.) Identify the threats to coral reefs from natural and human events/activities, i.e., water temperature, pollution, recreational over use, overfishing, invasive species, etc.
   c.) Discuss how corals need specific environmental conditions to survive. What kind of environmental conditions does a coral need to survive? What happens to the coral if the environmental conditions change?

2) Explain to the students that they will be building a diorama about coral reefs. Create criteria with the students that list the expectations for the project. While constructing the criteria with the students, be sure to include the following:
   - Name the different types of coral
   - Threats to coral
   - What environmental conditions are needed for coral to survive?

3) Have students research the topic areas on the internet and with books. Instruct students to list all websites and books that are used. They must take notes from the sites they visit and the books they choose. Some useful internet sites to suggest are
http://www.iyor-Hawaii.org/reef-facts
http://oceanservice.noaa.gov/education/kits/corals/welcome.html
http://oceanservice.noaa.gov/oceans/corals/
http://coralreef.noaa.gov/resources/multimedia/
http://oceanservice.noaa.gov/education/kits/corals/coral04_reefs.html

4.) Inform students that they will use their notes from their research for their diorama. Students will construct their diorama: Instructions for constructing the diorama:
   a.) Each student will bring in a shoebox or another similar type of box.
   b.) Using construction paper, glue and scissors, have students create the background for their ocean environment diorama. This would probably be blue paper on the surfaces.
   c.) Let the students be creative in how they depict their coral worlds, but remind them about the criteria for the project. They should include at least 6 types of coral, 10 threats to coral and an explanation of the environmental conditions that corals need to survive and what would happen if changes occurred.



LESSON 4 Processes or Events of the Earth and Atmosphere

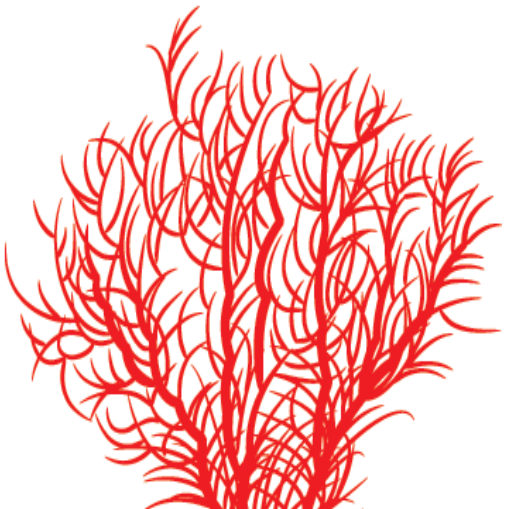
Directions: State if the process or event is slow or fast and whether the process or event is geological or meteorological.

Event/Process	FAST or SLOW	GEOLOGICAL (G) or METEOROLOGIAL (M)
Formation of ocean crust		
Tsunami		
Seafloor spreading		
Continental drift		
Wind/waves		
Subsidence (sinking of a portion of Earth's crust)		
Landslide		
Coral Formation		
Earthquake		
Flooding		

LESSON 4 Processes or Events of the Earth and Atmosphere

Teacher Answer Key

Event/Process	FAST or SLOW	GEOLOGICAL (G) or METEOROLOGIAL (M)
Formation of ocean crust	Slow	G
Tsunami	Fast	G
Seafloor spreading	Slow	G
Continental drift	Slow	G
Wind/waves	Fast	M
Subsidence (sinking of a portion of Earth's crust)	Slow	G
Landslide	Fast	M
Coral Reef Formation	Slow	G
Earthquake	Fast	G
Flooding	Fast	M



LESSON 4 Coral Reefs and Island Formation

Note Taking Sheet

Another important part of Island Formation is the formation of coral reefs.

The coral reefs existing today began growing as early as _____ years ago, but most of the ones we see today, took between 5,000 and 10,000 years to develop.

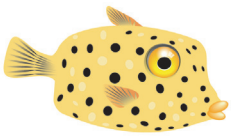
Corals are _____.

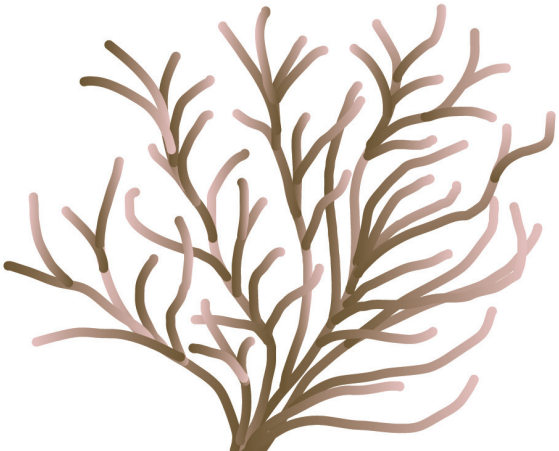
Corals need _____ to survive.

Each polyp builds a case of_____ around itself. This case remains after the polyp has died, and forms a foundation for _____ to build on.
Over time the coral colony forms the structures which make up _____.

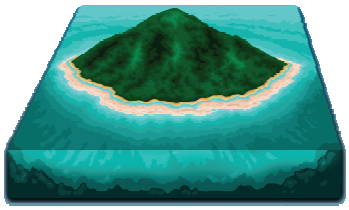
Coral reefs begin to form when free-swimming coral larvae called _____ attach to submerged rocks or other hard surfaces along the edges of islands or continents.

Once all the available horizontal space is colonized, _____ begin to grow upward _____until they reach just below the sea surface, maximizing as much space as possible for growth.

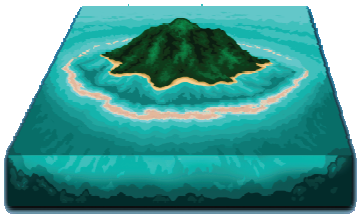




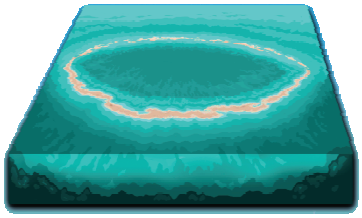
As the corals grow and expand, reefs take on one of three major characteristic structures —fringing, barrier or atoll.



_____develop along shoreline margins of islands, forming a skirt around the base of the land mass. Corals and other reef building organisms quickly colonize the available shallow waters that surround the island.



_____is a fringing reef that has been separated from land due to island subsidence (or sinking into the sea) and erosion, and encloses a lagoon between the reef and the subsiding island.



_____ are low-lying islands comprised of a ring of coral reef enclosing a lagoon. As islands continue to sink from subsidence and erosion, eventually disappear beneath the sea surface, an atoll will form as long as the rate of coral growth surpasses the rate at which the island is subsiding and eroding.

The relative ages of _____ can be compared based on the type of reef structure surrounding the _____.

Younger islands tend to have _____structures, and are usually high islands because of the amount of volcanic landmass still present above the surface.

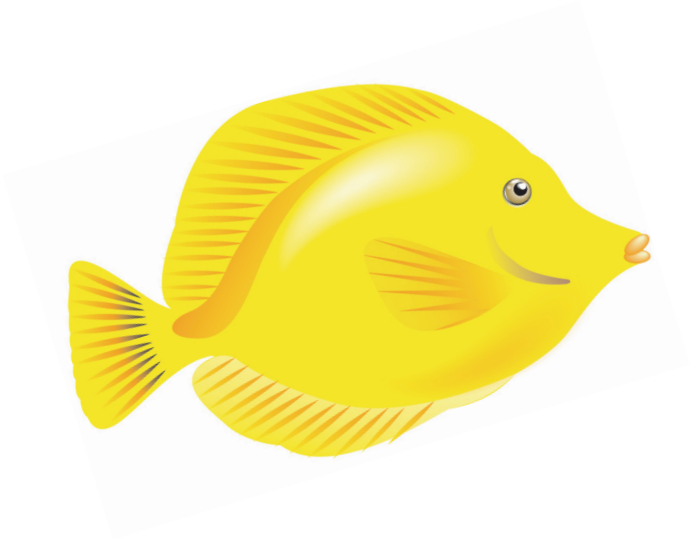
Older islands are composed primarily of sand or coral material, and have lagoons enclosed by _____. Low islands are considered _____ when the land mass is no longer above the sea surface.

LESSON 4 Coral Formation Game Results

Date: _____
Group Members:

ACTIVITY: Place your seafloor in the middle of your group, and divide 50 pennies, counting chips, or other small markers among your group. Standing a challenging distance away from your seafloor, toss your *Planula* (pennies/markers) on the seafloor. After 10 SECONDS, any planula not thrown is considered *dead*. Count the planula that were able to attach and survive, and record your results below: Repeat this activity *five* times.

Number Of Planula out of 50 that attached and survived. (10 seconds)	Decimal	Percentage of survival, %
Example: 10/50	0.2	20



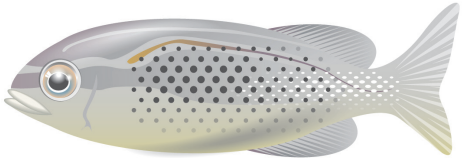
LESSON 4 What Have I Learned?

NAME: _____ **DATE:** _____

Directions: Answer the following questions in complete thoughts. You may draw diagrams to illustrate your thinking as well.

Explain in detail how a sudden Earthquake, volcanic eruption, flooding, or other fast process sometime shape and reshape islands.

Describe which slow processes changed the Hawaiian Islands and what changes occurred.

Describe and explain how coral reefs are part of the island formation process in the Hawaiian archipelago?

Based on the coral reef game results, what conclusions can you draw about coral reef formation and growth?