ANIMAL ARCHITECTS:

FIGHTING THE FORCES OF NATURE & FINDING STRUCTURAL STABILITY

A variation on the “Man and Animal” block

Waldorf Curriculum

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ADDITIONAL RESOURCES

Nest notecards, postcards, or photographs for Nature table

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The American Boy's Handy Book. Daniel Beard.

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Daily Meditation

I thank you, silent stone.
And bow myself before you:
I owe to you my plant nature.

I thank you, earth and plants,
And stood deep before you:
You help me rise to the animals.

I thank you stone, plant and animal,
And bend myself before you;
All three of you help me to become myself.

We thank you, O human child,
And lower ourselves devotedly before you;
For, because you exist, we exist.

In reply, there is thanks
From the all encompassing Godhead
In its simplicity and multiplicity;
In thanks, all that is, is intertwined.

LESSON PLANS
INTRODUCTION & ACTIVATION

Introduction -
"The Song of Hiawatha"
by Henry Wadsworth Longfellow

VI

"Hiawatha's Friends"

Two good friends had Hiawatha,
Singled out from all the others,
Bound to him in closest union,
And to whom he gave the right hand
Of his heart, in joy and sorrow;
Chibiabos, the musician,
And the very strong man, Kwasind.

Straight between them ran the pathway,
Never grew the grass upon it;
Singing birds, that utter falsehoods,
Story-tellers, mischief-makers,
Found no eager ear to listen,
Could not breed ill-will between them,
For they kept each other's counsel,
Spake with naked hearts together,
Pondering much and much contriving
How the tribes of men might prosper.

Most beloved by Hiawatha
Was the gentle Chibiabos,
He the best of all musicians,
He the sweetest of all singers.
Beautiful and childlike was he,
Brave as man is, soft as woman,
Pliant as a wand of willow,
Stately as a deer with antlers.

When he sang, the village listened;
All the warriors gathered round him,
All the women came to hear him;
Now he stirred their souls to passion,
Now he melted them to pity.

From the hollow reeds he fashioned
Flutes so musical and mellow,
That the brook, the Sebowisha,
Ceased to murmur in the woodland,
That the wood-birds ceased from singing,
And the squirrel, Adjidaumo,
Ceased his chatter in the oak-tree,
And the rabbit, the Wabasso,
Sat upright to look and listen.

Yes, the brook, the Sebowisha,
Pausing, said, "O Chibiabos,
Teach my waves to flow in music,
Softly as your words in singing!"

Yes, the bluebird, the Owaissa,
Envious, said, "O Chibiabos,
Teach me tones as wild and wayward,
Teach me songs as full of frenzy!"

Yes, the robin, the Opechee,
Joyous, said, "O Chibiabos,
Teach me tones as sweet and tender,
Teach me songs as full of gladness!"

And the whippoorwill, Wawonaissa,
Sobbing, said, "O Chibiabos,
Teach me tones as melancholy,
Teach me songs as full of sadness!"

All the many sounds of nature
Borrowed sweetness from his singing;
All the hearts of men were softened
By the pathos of his music;
For he sang of peace and freedom,
Sang of beauty, love, and longing;
Sang of death, and life undying
In the Islands of the Blessed,
In the kingdom of Ponemah,
In the land of the Hereafter.

Very dear to Hiawatha
Was the gentle Chibiabos,
He the best of all musicians,
He the sweetest of all singers;
For his gentleness he loved him,
And the magic of his singing.

Dear, too, unto Hiawatha
Was the very strong man, Kwasind,
He the strongest of all mortals,
He the mightiest among many;
For his very strength he loved him,
For his strength allied to goodness.

Idle in his youth was Kwasind,
Very listless, dull, and dreamy,
Never played with other children,
Never fished and never hunted,
Not like other children was he;
But they saw that much he fasted,
Much his Manito entreated,
Much besought his Guardian Spirit.

"Lazy Kwasind!" said his mother,
"In my work you never help me!
In the Summer you are roaming
Idly in the fields and forests;
In the Winter you are cowering
O'er the firebrands in the wigwam!
In the coldest days of Winter
I must break the ice for fishing;
With my nets you never help me!
At the door my nets are hanging,
Dripping, freezing with the water;
Go and wring them, Yenadizze!
Go and dry them in the sunshine!"

Slowly, from the ashes, Kwasind
Rose, but made no angry answer;
From the lodge went forth in silence,
Took the nets, that hung together,
Dripping, freezing at the doorway;
Like a wisp of straw he wrung them,
Like a wisp of straw he broke them,
Could not wring them without breaking,
Such the strength was in his fingers.

"Lazy Kwasind!" said his father,
"In the hunt you never help me;
Every bow you touch is broken,
Snapped asunder every arrow;
Yet come with me to the forest,
You shall bring the hunting homeward."

Down a narrow pass they wandered,
Where a brooklet led them onward,
Where the trail of deer and bison
Marked the soft mud on the margin,
Till they found all further passage
Shut against them, barred securely
By the trunks of trees uprooted,
Lying lengthwise, lying crosswise,
And forbidding further passage.

"We must go back," said the old man,
"O'er these logs we cannot clamber;
Not a woodchuck could get through them,
Not a squirrel clamber o'er them!"
And straightway his pipe he lighted,
And sat down to smoke and ponder.
But before his pipe was finished,
Lo! the path was cleared before him;
All the trunks had Kwasind lifted,
To the right hand, to the left hand,
Shot the pine-trees swift as arrows,
Hurled the cedars light as lances.

"Lazy Kwasind!" said the young men,
As they sported in the meadow:
"Why stand idly looking at us,
Leaning on the rock behind you?
Come and wrestle with the others,
Let us pitch the quoit together!"

Lazy Kwasind made no answer,
To their challenge made no answer,
Only rose, and slowly turning,
Seized the huge rock in his fingers,
Tore it from its deep foundation,
Poised it in the air a moment,
Pitched it sheer into the river,
Sheer into the swift Pauwating,
Where it still is seen in Summer.

Once as down that foaming river,
Down the rapids of Pauwating,
Kwasind sailed with his companions,
In the stream he saw a beaver,
Saw Ahmeek, the King of Beavers,
Struggling with the rushing currents,
Rising, sinking in the water.

Without speaking, without pausing,
Kwasind leaped into the river,
Plunged beneath the bubbling surface,
Through the whirlpools chased the beaver,
Followed him among the islands,
Stayed so long beneath the water,
That his terrified companions
Cried, "Alas! good-by to Kwasind!
We shall never more see Kwasind!"
But he reappeared triumphant,
And upon his shining shoulders
Brought the beaver, dead and dripping,
Brought the King of all the Beavers.

And these two, as I have told you,
Were the friends of Hiawatha,
Chibiabos, the musician,
And the very strong man, Kwasind.
Long they lived in peace together,
Spake with naked hearts together,
Pondering much and much contriving
How the tribes of men might prosper.

Main Lesson Book: view several pictures of beavers, then have your child compose a short text and corresponding illustration of Kwasind diving into the river to capture the King of Beavers.

Activation

Charlie the Tramp

Parent background: **Behavior** is anything an animal does involving action and response to a stimulus such as walking, blinking, swimming, breathing, and eating. There are two main patterns of animal behavior: inherited, or inborn, behavior and learned behavior.

Inborn behaviors are passed on from parents to offspring through their genes. For example, fiddler crabs are born knowing how to dig burrows. An inborn behavior can be as simple as moving toward or away from a stimulus, such as a snail retreating into its shell during dry weather. In higher invertebrates and vertebrates, the simplest form of inborn behavior is a **reflex**. A reflex, such as a frog jumping when touched, is simply an automatic reaction. A more complex inborn behavior is called an **instinct**. When a snail digs a hole to lay its eggs, or when a fiddler crab waves its claw to attract a female, the animals are acting on instinct.

Learned behavior is behavior that has changed because of a certain experience. For example, a goldfish can be trained to come to the water's surface when a light is flashed. An organism's pattern of behavior is related to the nature of the organism's environment, including kinds and numbers of other organisms present, the availability of food and other resources, and the physical characteristics of the environment. When the environment changes, behavior patterns also change.

Read Charlie the Tramp. Explore the concept of learned versus instinctive behaviors with your child by performing the following experiments:

Learned Behavior:
Take a ruler between your thumb and forefingers. Drop it through your child's thumb and forefingers, having her attempt to catch the ruler before it hits the floor. With practice, she will learn to catch the ruler more quickly, demonstrating a learned behavior.

Instinctive Behavior:
Have your child close her eyes and lie down on the floor. Describe a peaceful scene to her, such as "Imagine you are the only one lying on the beach listening to the waves of the ocean. You are watching the waves come in and out, in and out, in and out." (saying it softly)

At the point where you feel she is calmed and relaxed, drop a book or a hard object on the floor (or set a radio near you in advance to loud music and turn it on suddenly during the story). Your child will most likely jump in surprise, open her eyes, and look around the room for the cause of the noise. This behavior is an instinctive response. If an animal is startled by a noise, his instinct may tell him that a predator is near by.

You and your child could also perform this experiment on another family member.

Animals behave in certain ways for three basic reasons:

a. to find food
b. to avoid predators
c. to reproduce

Explain that **learned behavior** is behavior changed by experience. **Instinctive behavior** is behavior that occurs from instinct. Instincts are behaviors animals are born with. Examples: Bees are born knowing how to make honey. A spider knows how to make a web. A bird knows how to make a nest.

Then begin the Animal Architects unit.

EXPLORATIONS - PART ONE

Who Are the Animal Architects?

Start by introducing the word "habitat" to your child. Explain that an animal's habitat provides the food, water, shelter, and space it needs to survive. You might ask your child to tell you what she needs to survive, so that she can see that humans have habitat needs too. Ask your child to name different habitats, such as fields, forests, oceans, deserts, streams, or rain forests. Make a chart listing these. Then have her list some of the animals that live in each habitat.

Next, explain that some animals build special homes in their habitats. Some examples are beaver lodges, bird nests, fox dens, and prairie dog holes. The homes provide shelter from weather, protection from predators, and places to raise young. Point out that many animals – such as lions, antelopes and deer – do not build special homes.

Have your child take a piece of paper and draw a line down the middle, making two columns. On the left, list five animals you know of which live in your region. On the right, write everything you know about the activities of each, including finding food and water, providing themselves with shelter, staying warm, keeping safe, etc. It is fine for both of you to brainstorm together, or this can be independent work.

Now, looking at what you have written down, what are some of the reasons an animal might have to build?

Storing Food

Set A: Honey Bee

"The Queen Bee" – fairy tale by the Grimm Brothers

The honey bee makes its own building material: beeswax.

Parent background: http://www.goldenblossomhoney.com/honeybee.html

Tell your child a story about the honey bee hive. Include the roles of all the workers, the drones, and the queen. Read the fairy tale "The Queen Bee."

When honey is sold in the comb, the comb can be eaten along with the honey, something many consider quite a treat as it is where the sweetest honey is found. Purchase some honey with the honeycomb intact and study its structure (if this is not possible many excellent pictures of a honeycomb can be found on the Internet, such as http://www.gpnc.org/honeybee.htm). Taste the honey. If you can, visit a nature center, park, museum or local farm with a live honey bee display.

Honey bees make honey primarily so that they will have a food source during winter, when flower nectar is scarce. These bees do not hibernate; they remain active throughout the winter,

although they cannot go outside the hive when temperatures are too low. Read more about honey bees on page 211 of Winter World, as well as Chapter 23 of that book.

This is not the time to learn everything there is to know about honey bees, however; this section of the lesson plans is simply an overview of different animals which build and why they do so.

Building a Trap

Set B: Spider

Spiders Spin Webs

The spider also makes its own material: spider's silk.

Read Spiders Spin Webs. Take a Nature walk throughout your house and look for spider webs and cobwebs. (What's the difference? http://www.straightdope.com/mailbag/mcobweb.html)

What kinds of prey are spiders trying to trap with these webs? Look at the location of the webs – are they found in the same areas of the house that a spider's prey would be? How does the spider make its web into an effective trap? Some of the threads in the web are sticky (not the main spokes, which the spider uses to travel around, or the center where he sits – this helps the spider keep from getting trapped himself) and when a small insect comes in contact with the web, it becomes stuck and completely helpless. The spider then may eat his prey at his leisure.

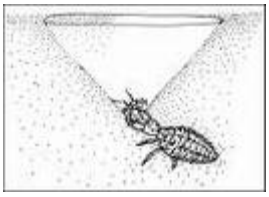
Set C: Ant Lion

The ant lion builds with soil. It does not create its own substance, but has to learn how to make the soil do what it needs it to do. This is accomplished by shaping soft sand into a funnel-shaped pit. An ant walking along the edge of the funnel looses some soil and slides down helplessly in the avalanche. The ant lion is waiting at the bottom and grasps the ant in its jaws. There is no way for the ant to climb without loosening additional sand and sliding back down again.

Purchase and set up an aquarium for ant lion observations: http://www.antlionfarms.com/.
You may keep your ant lion alive by feeding him one ant every day.

Parent background: http://waynesword.palomar.edu/pljuly97.htm

The out-of-print Burgess Book of Nature Lore contains a good chapter on ant lions.



Set D: Bird

Bird Egg Feather Nest

The bird forages, building with a wide variety of materials depending on what it can find. Birds use natural materials as well as those created by humans.

Parent Background: Bird Egg Feather Nest

Place nest cards on your Nature table. Study them carefully. How do the nests differ? In materials, in location, in construction? Let your child look through Bird Egg Feather Nest to learn more about different types of nests, structures, and shelters birds build to protect their eggs and young ones.

Take a Nature walk and look for abandoned nests; these are more easily found in winter. Don't forget to look for nests in other places besides high in trees – use the information you learned in Bird Egg Feather Nest to try to find some other nesting locations. Do not take any of the nests.

If you live in Vermont (in the United States), check out the Vermont Institute of Natural Science for their nests and supplemental materials: http://www.vinsweb.org/education/elf/units/nst.html

Set E: Beaver

The beaver builds with sticks and mud. These materials are not optional.

Parent background: http://www.geocities.com/bobarnebeck/dams.html

Try to locate a beaver dam you can visit with your child.

Even if you can't observe beavers in the wild, many nature centers and parks have exhibits about this fascinating animal. One near us has a replica of a beaver lodge which you can walk into. Check near you for similar exhibits.

Why Beavers Build Dams:
Charlie the Tramp sets forth the premise that beavers will dam a stream because they find the sound of running water irritating. This has, in fact, been scientifically proven to be true:
http://www.naturealmanac.com/archive/beaver_dams/beaver_dams.html

Set F: Prairie Dog

The Prairie Dog Town

The prairie dog also builds with soil, but instead of creating a design which is inherently unstable (like the ant lion), he works to build a sturdy series of passages below the earth.

Talk about the book Little House on the Prairie (read in the Baking unit). What was it like living on the prairie? What predators did the prairie dogs have to hide from?

Read a book about Prairie Dogs. I have recently discovered that Frank L. Baum (the creator of the Wizard of Oz) wrote a book called Prairie-Dog Town, now back in print from Addison Press. I haven't had a chance to look at this, but it sounds fascinating!

Parent Background: http://www.desertusa.com/dec96/du_pdogs.html

You'll see from these six animals – storing food, building a trap (to catch food), and building a home are all instinctive activities of animals which are essential to their survival. Revisit the earlier discussion from Activation of instinctive versus learned behaviors. Instinctive behaviors are necessary for survival. Learned behaviors are optional, but may increase survival.

If you believe in evolution, you can point out to your child that animals without these instinctive skills would have been less likely to survive and therefore less likely to reproduce.

Main Lesson Book: have your child compose a short text and corresponding illustration to identify some of the animals which build and explain why they do so.

EXPLORATIONS - PART TWO

Escape from Abel's Island: Fighting the Forces of Nature

Start by reading Chapter One of Abel's Island with your child.

Parent Background: **The Meaning of Force**
A **force** is defined as a push or pull that causes an object to move or speed up (accelerate), to slow down (decelerate) or even stop, or to change the direction of the object's motion.

Whenever there is an interaction between two objects, there is a force upon each of the objects. When the interaction ceases, the two objects no longer experience the force. Forces only exist as a result of an interaction.

all of the parent background information regarding forces is taken from The Physics Classroom: http://www.glenbrook.k12.il.us/gbssci/phys/Class/newtlaws/u2l2a.html

> Note: We will only be studying the contact forces here, as the action-at-distance forces (such as electrical force and magnetism) are considered too abstract for this age.

Set A: Normal Force
Parent Background: The normal force is the support force exerted upon an object which is in contact with another stable object. For example, if a book is resting upon a surface, then the surface is exerting an upward force upon the book in order to support the weight of the book. On occasions, a normal force is exerted horizontally between two objects which are in contact with each other.

Tell your child that a [contact] force is anything that touches you and causes you to speed up, slow down, or change your direction. Look at what is touching you right now. You may be sitting on a chair or standing on the floor. The chair keeps you from falling to the ground. The floor keeps you from falling into the basement. We call this support "normal force."

> The word force is used in many other ways, too. When someone is said to have a forceful personality, it means that t hey are bossy or overpowering and make you change your mind or do something you wouldn't normally do. Their personality makes you do something. If someone is pressuring you to do something you don't want to do, you tell them, "don't force me."
>
> When you feel a powerful urge, such as saints feel when they are called to religious life, it is called a force from within. And sometimes, when people don't know why they do something or why a thing happens, they describe it as being acted upon by a mysterious force.

The more of your body is touching a stable surface, the more you feel its force supporting you. When people feel dizzy, they automatically lie down to feel better. Try balancing on one foot, then raise yourself up to your tippy toes. Do you lose your balance? Now try lying down flat on the floor. You probably don't have any fear that you will fall off the floor! The floor is stable and supporting your whole body.

Read chapters 2, 3, 4 of Abel's Island.

Set B: Applied Force

Parent Background: An applied force is a force which is applied to an object by a person or another object. If a person is pushing a desk across the room, then there is an applied force acting upon the object. The applied force is the force exerted on the desk by the person.

When Abel and Amanda were caught in the hurricane, what forces were acting upon them? In other words, what was pushing against them and causing them walk more slowly and with difficulty? The wind. It was not supporting them (like a normal force), it was pushing on them and keeping them from going where they wanted to go. This is called "applied force." The same thing happened to Abel when he tried to fight the rushing water but was unable to get across the river. The river forced him back.

As you go through the book, make a list of all the ways Abel tries to get off that island. Include what it was he had to fight or overcome, and draw a small sketch of his solution. Keep a record of them in a journal called Physics All Around Me.

Also use the journal as you try the suggested experiments for this unit. The Physics journal is a place to keep notes and sketches of what happened in each experiment as well as your conclusions. More formal and polished descriptions of the experiments and corresponding illustrations are placed in the Main Lesson Book, a place where one puts only the best work. The Physics journal is more informal and should be used heavily throughout this unit.

Physics Journal: Experiments with applied force

- There are many examples of applied force throughout the home. Use a paint can opener to open a can of paint. Lift and move objects out of the way while vacuuming. Pull open the oven door while cooking, then push it shut again. Stand back to back with your daughter, link arms, and dig in your heels – then try to push against her to get her to take several steps forward. Ask your child to name some other examples of applied force.

Main Lesson Book: have your child compose a short text and corresponding illustration to give some examples of normal and applied force

Read chapters 5, 6, 7 of Abel's Island.

C: Frictional Force

Parent Background: The friction force is the force exerted by a surface as an object moves across it or makes an effort to move across it. The friction force opposes the motion of the object. For example, if a book moves across the surface of a desk, then the desk exerts a friction force in the opposite direction of its motion. Friction results from the two surfaces being pressed together closely, causing intermolecular attractive forces between molecules of different surfaces. As such, friction depends upon the nature of the two surfaces and upon the degree to which they are pressed together.

When Abel fell out of his tree while asleep, he brushed by some branches which broke his fall. A non-moving thing brushing against a moving thing will slow it down – and two moving things sliding against one another will both start to go more slowly. This is called friction.

Physics Journal: Experiments with frictional force

- Take your two hands and place them with palms facing. Rub your palms briskly together. Feel the heat? This is the heat caused by friction. Fires are started in the same way. Practice making a fire with a flint.

- The closest thing we have on Earth to a frictionless surface is ice. Take a book, a stapler, a piece of cork, and any other flat object you can find and try to slide them rapidly across a table top. Now try the same thing with an ice cube. The ice cube should move much more quickly than any of the other objects. Go ice skating. See how it feels to glide across the surface of the ice. Of course, without friction to slow you down, you move very fast so falling is very painful! Cars must be very careful driving on ice because it is so slippery. When there is an icestorm, the city will put down sand to give the cars some traction. People also carry kitty litter in their cars for the same reason.

- Go back to your tabletop and try rolling an orange across it. Why does the orange move so quickly? Because it is constantly rolling, the table is only touching a little part of the orange at a time, and that part is constantly changing. So the friction doesn't have much time to work to slow the orange down.

- Another good way to illustrate this is with a can of soup. Take a can of soup and set it on the table standing up. Give it a good push. Now lie the same can down on its side and give it a good push. What is the difference? Nothing about the can has changed – it is made of the same materials, weighs the same, etc – obviously the shape of the can where it touches the table has a major influence on how friction will affect it.

- Over time, though, the force of friction slows everything down – nothing can move forever. It would take a very long expanse of table for the orange to slow down and stop but it would, eventually. Try rolling your orange along a piece of carpet instead. Carpet exerts more friction on the orange and you will see that it slows down much more quickly.

Main Lesson Book: have your child compose a short text and corresponding illustration to give some examples of friction and how it can be overcome

D: Air Resistance Force

Parent Background: The air resistance is a special type of frictional force which acts upon objects as they travel through the air. Like all frictional forces, the force of air resistance always opposes the motion of the object. This force will frequently be neglected due to its negligible magnitude. It is most noticeable for objects which travel at high speeds (e.g., a skydiver or a downhill skier) or for objects with large surface areas.

Abel and Amanda experience applied force when they try to walk against the fierce winds to make their way back home. When they submit to the storm and begin to walk with the direction of the wind they find it is much easier. But even when the air is not moving so fiercely, it is actively pushing against you with a small amount of force called "air resistance force." This is one of the forces Abel is unable to overcome when he tries to launch the lightweight rope across the stream. The rope is not heavy enough to push back against the air and continue to travel.

Physics Journal: Experiments with air resistance

- Air resistance experiment which explains parachutes: http://www.seed.slb.com/en/scictr/lab/drop/

- In general, contact forces (such as those studied here) are more appropriate for this age because at-a-distance forces are more abstract and are more difficulult to understand. However, gravity is easy for any child since he sees the effects of it every day. Practice Galileo's famous gravity experiment:

  you will need:
  a partner
  a chair
  a piece of newspaper
  an orange
  a grape

1. Place newspapers on the floor around the chair.
2. Stand on the chair while your partner lays on the floor peering at the newspaper.
3. Hold the 2 oranges in each hand. Extend your arms straight out away from your body (and over the newspapers) so that each orange is the same height from the floor. Let go of both oranges at the same time. Did they hit the newspaper at roughly the same time?
4. Now stand in the same position but this time hold a orange in one hand and a grape (or some other small object) in the other hand. Let go of both of these objects at the same time.

Notice how the orange and the grape still hit the floor at the same time. Most people would have guessed that the orange would hit the floor first but gravity pulls all objects downward at the same speed, regardless of their weight.

However, air resistance does play a part in this equation. Air resistance is one of the forces that can act against the pull of gravity and affect it, like when a person jumping out of an airplane uses a parachute to land on the ground safely.

- Have your child try the ubiquitous egg-dropping experiment, where you are given the task of dropping a raw egg from a 2nd story window and having it land safely. Initially, focus on adding cushioning around the egg to prevent it from breaking but, eventually, your child should decide that the solution is to slow the egg down to keep it from falling so quickly. Then have the focus be primarily on the parachute, with just a bit of padding around the egg to help it with the final landing. Each time, drop a plain egg along with your protected egg. As she learns to slow the one egg down more and more using the parachute, the difference in their rates of fall will be most obvious with another egg alongside to compare it to.

  Use the Physics journal here as a place to pose the initial problem, brainstorm solutions and draft sketches and designs. The evolution of the design process is the primary product in this activity. Even if you never design a parachute which will help the egg arrive safely on the ground, she will see how she successfully altered its rate of fall.

- While parachuters learn to use air resistance to their advantage, skiers learn to overcome it. The more surface area an object has, the more air resistance can affect it. Take your child skiing or sledding and watch her observe how much faster she can go when she bends over or curls her body up into a little ball.

Main Lesson Book: have your child compose a short text and corresponding illustration to give some examples of air resistance and how it can be overcome

Set E: Spring Force

Parent Background: The spring force is the force exerted by a compressed or stretched spring upon any object which is attached to it. An object which compresses or stretches a spring is always acted upon by a force which restores the object to its rest or equilibrium position. For most springs (specifically, for those which are said to obey "Hooke's Law"), the magnitude of the force is directly proportional to the amount of stretch or compression.

Abel tries to overcome air resistance by giving his rock a little bit of extra “oomph” using a slingshot made of elastic, his suspenders. Elastic is a kind of springy fabric when stretches out when you tug on it. When you let go, it comes back to its original shape with a bounce. A rubber band does the same thing.

Physics Journal: Experiments with spring force

- Try using a slingshot made of a rubber band. When you let go, you will feel the force rippling through your arm. The remaining force goes into the pebble and helps give it an extra push through the air. (if desired, here tell the Biblical story of David and Goliath to your child)

- We use springs in all aspects of our lives. Take a Physics walk (with journal in hand) and identify some machines in your home which make use of springs. Visit an auto mechanic or garage and ask to see the springs in your car. Take apart a ball point pen and watch the little spring hop out of the top of the pen. It has the force to jump like that because you have been compressing it – when the spring is released, all the force of its

Set F: Tensional Force

Parent Background: The tension is the force which is transmitted through a string, rope, or wire when it is pulled tight by forces acting from each end. The tensional force is directed along the wire and pulls equally on the objects on either end of the wire.

The final contact force is tensional force. This force can be felt by anyone who has ever played tug-of-war. When two people are both pulling on a rope, and pulling it taut, the rope begins to have some force built up in it. When one side lets go of the rope, the other person falls flat because of the force.

Abel wasn't successful at throwing his rock across the stream, but his plan had been to have a sturdy rope which would get stuck on something at one end of the river; he could then pull on the rope hand over hand and use it to guide him across. This only works if the rope is secure at one end. If a rope is fastened to something and you are pulling on it – and then it comes free – you will fall. This is reason that safety precautions are so important in rock climbing. Go to a rock climbing wall and see how seriously everyone there takes safety.

Tensional force is different from spring force.

- **Spring force involves something elastic being stretched out of shape (or compressed) and then returning to rest.**
- **Tensional force involves something non-elastic which is simply being pulled tightly at both ends.**

Tensional force is more like a road or pathway; the rope carries the force of the two things pulling tightly on it at either end. When I am pulling on a rope in a game of tug-of-war, it is just as if I were pulling on the person at the other end, taking their jacket or their arm and pulling on them. But that force is going through the rope instead. They are pulling just as hard at their end, and the rope contains the power of the two combined forces. When I let go, all of that force travels through the rope and knocks them over. The harder I pull, the more force I am transmitting through the rope. If I am hardly pulling at all, and let go, the other person doesn't feel much of anything at all. Try it.

Physics Journal: Experiments with tensional force

- Visit a circus and see a tightrope walker. Or read The Man Who Walked Between the Towers. Imagine how impossible that would be walking on a springy line, which was constantly flexing up and down as you took each step!

- Make a tin can telephone: http://www.dsokids.com/2001/dso.asp?PageID=100

Main Lesson Book: have your child compose a short text and corresponding illustration to explain how a spring works and the difference between a spring and a tightrope

Have your child begin work on the cumulative project at this time.

Read the remainder of Abel's Island. Complete Art and Handwork projects inspired by the book such as clay sculpture, pottery, sketches and sculputures of plants, and charcoal drawing.

As you go through the book read, then revisit scenes in light of what force is illustrated, such as the Spring Force when the cat falls (Chapter 19): "The cat leaped. Abel gripped his twig. It bent like a bow when she struck it, swung back, swayed, and shook in his grasp, and he could hear the cat drop, hitting branches as she fell, yowling and screaming in pain and amazement."

EXPLORATIONS - PART THREE

Finding Structural Stability

Re-examine the animal architects' work with an eye toward what forces and other challenges must be overcome and what aspects of their design make it successful.

Set A: Honey Bee

The hexagon design of a beehive cell makes it exceptionally strong. A hexagon cell can withstand being pushed upon all sides without collapsing. The tessellation of the hexagon also means that there is no wasted storage space. It is a very efficient design.

Parent Background: http://www.sciencenews.org/pages/sn_arc99/7_24_99/bob2.htm

Why the Hexagon?
http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artsep98/hexagon.html

Introduce the hexagon shape to your child.

Practice making tessellations with a variety of sizes and shapes of ceramic tiles.

Have your child practice drawing tessellating hexagons in Form Drawing. Add some of the best forms to your **Main Lesson Book**.

Using Drawing From the Book of Nature as a resource, practice sketching a honeybee. Include your best drawings in your **Main Lesson Book**.

Begin a quilt project from Magical Hexagons to further explore the properties of a hexagon.

Set B: Spider

Considering the spider's prey, do you think they have designed the trap which would be most efficient at catching it? A spider web has to do several things – be located where insects will be travelling, lure them in, and prevent them from escaping. Since a spider's web is organic, that is, he creates it himself, he is able to build a web in whatever spot looks good and to move and build another one in a different place if he chooses to. When the web is torn, he can quickly and easily fix it. The web captures insects because it is sheer. They cannot see it. Then the spider's silk must be exceptionally strong, as the struggling prey will try to break free. Lastly, the spider makes its web sticky.

Parent Background: http://www.wsu.edu/DrUniverse/spiders.html

The force of a struggling insect against the web is, of course, applied force. The stickiness of the web adds more resistance which the insect is unable to overcome – there is too much friction. The web must also be strong enough for the spider to run along it and to bend, not break, when the wind blows.

Read the fable of The Oak Tree and the Reed:

The Oak Tree and the Reed

The oak said to the reed that grew by the river, "It is no wonder that you make such a sorrowful moaning, for you are so weak that the little wren is a burden for you, and the lightest breeze must seem like a storm wind. Now look at me! No storm has ever been able to bow my head. You will be much safer if you grow close to my side so that I may shelter you from the wind that is now playing with my leaves."

"Do not worry about me," said the reed, "I have less reason to fear the wind than you have. I bow myself, but I never break. He who laughs last, laughs best!"

That night there came a fearful hurricane. The oak stood erect. The reed bowed itself before the blast. The wind grew more furious, and, uprooting the proud oak, flung it on the ground.

When the morning came there stood the slender reed, glittering with dewdrops, and softly swaying in the breeze.

Observe a spider building a web if you can. Read The Very Busy Spider. Did Eric Carle accurately portray the steps a spider takes when building a web? Explain how the pattern of the web contributes to its strength.

Take your Physics All Around Me journal and sketch several spider webs both completed and in progress. See if you can find an abandoned spider web and try to figure out why it was abandoned. Many spiders will stop building in an area where their webs are being destroyed over and over, like if a human walks through them.

Main Lesson Book: have your child compose a short text and corresponding illustration to explain the steps a spider takes to build its web and how it captures its prey

Continue with Form Drawing. Spiral forms are an excellent connection with the spider, both those which go from the center outward and those which spiral from the outside in. If you are doing forms on an axis try folding your paper in half and then rotating it and folding in half again – open (so that you can see the faint line of a cross centered on your paper) and practice drawing the spokes of a web.

Begin Charlotte's Web as a read-aloud.

Set C: Ant Lion

The ant lion has a marvelous way of building, where he takes advantage of one of the qualities of sandy soil – the fact that it is very difficult to build a stable hole in dry sand. Try digging a hole the way an ant lion does, by throwing sand up and out of the hole, and shaping a cone shaped pit. Watch how there is a limit to how deep you can make your hole before the sands on the side begin to slide down to the bottom. If you take a ant lion and put him in a pile of sugar or salt, he will be able to build in the same way, as these materials have similar qualities. What kinds of soil do you think an ant lion would not be able to build in? How about if the sand was wet? If you can, try it with your ant lion and see.

Wet sand is harder to move than dry sand because it sticks together; there is more friction. However, when you build something out of wet sand it will stay together better than dry sand – once you overcome the friction and begin to build, the friction starts to work on your side instead of against you, and the structure (like a sand castle) becomes more stable because of it. Try building a sand castle out of completely dry sand, then try it with wet sand, and see for yourself.

The funnel shape (or upside down cone) is an exceptionally stable design once built. Any sand which begins to slide down the side of the pit serves only to reinforce its sloping sides and a stable bottom. How many other traps can you think of which become stronger as the animal tries to escape? Try some experiments with a kitchen funnel to see how easily things are pulled down into it, and how difficult it is for them to get back out. For example, balance a funnel on one end in a tray of sand, somewhat like an ant lion's pit. Lay more grains of sand or small items on the edge of the funnel, then jostle them slightly as if they were a walking ant. Notice how much more likely an item is to fall into the cone than to fall away from it.

Or, making a pit in a container of sugar, drop a raisin into it to mimic your ant. Once you have a raisin or other small item inside your cone, try to lift it up with a toothpick, having it climb up the sides of your funnel. See how many grains of sugar fall (and, if not for the toothpick, the raisin would be carried along with them), disturbed by the motion of the climbing.

Physics note: The priority here is that your child experiences how objects react to being pushed or pulled in as many different ways as possible. Any activity that gets her pushing, pulling, or rolling things down a slope gives her increasing familiarity with how things react to a force. Document your experiences in your **Physics Journal**.

Main Lesson Book: have your child compose a short text and corresponding illustration to explain how an ant lion builds a trap for ants and why it works so well

Set D: Bird

There are a variety of nest-building styles. Some birds build very precisely, where others build sloppily-formed nests. In general, the bird must start first with anchor points, choose sticks which can be wedged securely into the crook of a tree (or other nest-building location). From these anchor points a main framework is the established, and then the gaps are filled in with a building material.

Birds use weaving techniques for strength and stuffing materials for insulation. Read Bird Egg Feather Nest to see how weaver birds utilize the same over-and-under pattern as human textile weaving.

Purchase a basket making kit, or basketry supplies, and have your child practice weaving reeds to form a sturdy shape.

How amazing it is that birds instinctively know how to do this, yet humans must be taught! Have your child write a story which describes how the first human learned how to weave – was it from watching the birds? Add this story and its illustrations to your **Main Lesson Book**.

Set E: Beaver

Read The Adventures of Paddy the Beaver with your child.

Try the following game with your child: gather a collection of sticks in all different shapes and sizes. Place them all in a pile in the center of the table. Each person chooses a stick, then studies it carefully for five minutes. Look at your stick all over, as if you were getting to know it like getting to know a person. When the timer dings, place all the sticks back in the center and shuffle them. Can you find your stick again? We have to work very hard to learn our sticks, whereas a beaver can get to know a stick in seconds. He can immediately assess where it will fit best in his design. A beaver is a master builder with intimate knowledge of his craft.

Just as with a bird nest, beavers use weaving for strength in their dens. Give your child a set of mini bricks from a building kit. Try building a wall with matching seams (all the bricks are piled straight on top of one another with no over-lapping). Notice how easily it begins to topple over. Now try building your brick wall properly. This makes the design more stable and gives it strength. Finally, try using mortar to fasten the bricks together in your wall. Now it is exceptionally strong. Beavers use mud as the mortar in their design. Do you think that humans learned to use mortar from watching animal architects at work?

> Parent Background: What is mortar made of?
> To achieve the balance of properties for a particular application, you mix different proportions of portland cement, hydrated lime, sand and water. Portland cement yields greater compressive strength but lower water retention during the cure, thus risking shrinkage cracks. Lime yields lower compressive strength but greater bond strength and flexibility. Sand, the aggregate, adds volume and minimizes shrinkage as the cement dries. Water makes the mix workable and activates hydration, the chemical reaction that hardens the cement.
>
> In effect, mortar is a specialized type of mud.

Make a model of a beaver den following the suggestions given in Learning About the World Through Modeling.

What forces must a beaver dam withstand? Obviously a beaver must know how water works as intimately as he knows his building materials. In fact, water resistance is a type of friction. That is, things slow down as they fall through water. Take your child to a swimming pool to jump off

of the diving board. Can you feel the water pushing back against you dive into it? More streamlined objects can move through water more easily. This is why serious swimmers shave their bodies before a race, to reduce the amount of friction. It is also why you travel through the water more easily when you are diving (and your body is in a straight line) then when you jump off the diving board and do a cannonball. Ouch!

Examine the beaver's body. Can you tell that a beaver is built to travel through water?

Make a model beaver family to live in your den.
Parent Background: Learn more about beavers and their dens in Winter World.

Set F: Prairie Dog

The prairie dog is a most interesting animal. Whereas the ant lion uses the instability of loose sandy soil to his advantage, the prairie dog must take dirt which is loose and pack it together to make it stronger. His tunnels must not collapse upon him. Look again at the illustrations in Prairie Dog Town. Remember how Abel was leery of building a tunnel under the river because he didn't know how to make it strong enough that it would not collapse. How do prairie dogs do it? It is not safe for you to try to tunnel below the earth, but talk with your child about the miracles of animal instincts and how there are so many things about them which humans do not understand.

Parent Background:
"When Animals Use Science" article (from February 2, 2002)
http://rivapprod2.riverdeep.net/portal/page?_pageid=336,210772&_dad=portal&_schema=PORTAL

EXTENSIONS

Other Instinctive Animal Behaviors – Salmon Homing Instincts

http://www.col-ed.org/cur/sci/sci02.txt

Hibernation & Migration

Parent Background:

Bird Egg Feather Nest

Winter World: The Ingenuity of Animal Survival

Learn more about animals in your area and how they survive the winter. How do humans make sure they will survive the winter? Learn to think about humans in terms of their instinctive behaviors, learned behaviors, and habitat.

Independent Skills Review

Part One

Set C
have your child read the following (from http://www.yeworld.net/index/LSFP/ETFP/EFB/195_20021123/195%2020021123214449%20111.asp):

> **skill:** reading for comprehension, non-fiction text
> **check:** that the questions are answered correctly

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Text 13: The Ant Lion

If you are out walking in the countryside, and you happen to come across an area of dry, sandy soil, you may find some small holes in the ground, shaped like an upside-down cone, perfectly round at the top and tapering down to a point. If you then get a piece of grass, and gently touch the side of this hole, making a few grains of sand fall to the bottom, and a little creature may finally appear, looking for a meal.

The creature is called an ant lion and the hole or pit is the method it uses to catch its food. The ant lion is actually the wormlike young of an insect from the family Myrmeleonidae. It digs its pit by crawling backwards in a small circle. It uses one of its front legs to pile sand up on its head, and then twists its head quickly, throwing the sand out of the pit. Round and round it goes, in smaller and smaller circles, throwing out the sand, until it has cleared a pit of about 5 centimeters in diameter at the top, and 3 or 4 centimeters deep. Next it buries itself at the bottom, with just its strong jaws showing. Then it sits and waits with great patience.

Finally, an ant or another small insect will come by, and step into the pit. If it falls to the bottom, the ant lion will seize it in its jaws, and eat it. But if the ant tries to climb up the side of the pit, the falling sand will warn the ant lion at the bottom, and it will throw up sand with its head, causing a small fall of sand which will make the ant fan back down again, to its death.

1. The purpose of touching the ant lions hole with a piece of grass is to _____
A. try to catch an ant lion.
B. see how it catches insects.
C. give the ant lion some food.
D. make it bury itself in the sand.

2. According to the information given in the passage, the ant lion is a kind of _____
A. ant.
B. lion.
C. insect.
D. locust.

3. The main purpose of the second paragraph is to explain _____
A. how the ant lion digs its hole.
B. what kind of creature the ant lion is.
C. how the ant lion eats its food.
D. the direction in which the ant lion usually moves.

4. The ant lion uses its _____.
A. back legs
B. front legs
C. jaws
D. head

5. "creature" means _____.
A. crew
B. creditor
C. crisis
D. animal

Set F
Little House on the Prairie quiz (from http://library.thinkquest.org/J001777/game.html):

Let your child answer some from memory and scan the book to find the answers to others. The questions are **not** listed in the order in which these events occurred; this makes it more challenging for your child to find the correct passage. Have your child put the letter of the correct answer in the blank, as well as the exact page of the book on which she found the answer. This extra step of citing the source is good practice for future research projects.

skill: scanning familiar text to locate specific passages
check: that the questions are answered correctly
check: that correct page numbers are given

formatted to be a stand-alone worksheet

Little House on the Prairie

Question 1
Laura, Ma, Pa, _____ left the Little House in the Big Woods.

A: Grace and Carrie
B: Rose and Mary
C: Mary and Carrie

Question 2
They had to go through the town of _____.

A: Hourn
B: Pepin
C: Tracy

Question 3
Mary and Laura named the new black ponies Pet and _____.

A: Patty
B: Dixie
C: Old Gal

Question 4
Ma nearly broke her _____ while she was helping Pa build the house.

A: Ankle
B: Leg
C: Wrist

Question 5
Who got lost when the Ingalls family crossed the creek?

A: Ma
B: Jack
C: Mary

Question 6
A: When Jack found his way back to them, they welcomed him by _____.

A: Having a party!
B: Almost shooting him.
C: Giving him fresh meat.

Question 7
While Pa went hunting and looking for a good place to build the house, Mary and Laura helped tidy camp and then tried to catch a _____ for Ma.

A: A groundhog
B: A gopher
C: A prairie dog

Question 8
Mr._____ helped Pa build the house.

A: Scott
B: Edwards
C: Smith

Question 9
The first roof on the house was made of _____.

A: a tent
B: a wagon cover
C: shingles

Question 10
Mary, Laura, and Pa gathered _____ at the Indian camp.

A: Food
B: Guns
C: Beads

Question 11
The _____ followed Pa and Patty across the prairie.

A: Deer
B: Bears
C: Wolves

Question 12
What was the last item added to the house?

A: Doors
B: A floor
C: A well

Question 13
Who helped Pa build the well?

A: Mr. Edwards
B: Mr. Scott
C: Ma

Question 14
Back then people called malaria, a disease which mosquitoes give you, _____.

A: Fever 'n' gag
B: Fever 'n' ague
C: Fever 'n' a bag

Question 15
A circle of wolves totally surrounded the _____.

A: House
B: Stable
C: Well

Question 16
What kind of Indian stopped the war cries?

A: Osage
B: Balaboo
C: Iroquois

Question 17
They all left the little house on the prairie because
_____.

A: The crop was bad
B: They did not want the soldiers to come and force them out.
C: A fire destroyed everything they had.

Part Three

Set A
http://www.astrohoroscopes.com/puzzles/math/hexagon.html

skill: identifying hexagons, tessellations

Set A
http://www.naturalmaths.com.au/hexagonia/spatial.htm

skill: making hexagons, spatial relationships

Cumulative Project

Read some real estate ads from a newspaper together, then read these make-believe examples and ask your daughter to guess which animals might want each type of habitat:

- Delightful Dens: Bottomland hardwood forest available in Louisiana. Our hollow logs and large tree cavities make great dens. Plenty of berries, nuts, insects and carrion. Give us a call before snow starts to fall. (Answer: Louisiana Black Bear)

- Perfect Pool: Vernal pools available Spring 2000. Located in a shallow depression of a beautiful wooded area. You won't find a better breeding habitat. Call now, before the pool dries in the hot summer sun. (Answer: Spotted Salamander)

Your child will write a series of classified ads that describes an animal's habitat and/or home. Decide in advance how many ads you want him/her to write, or do this project as a group with other homeschooling students or get a penpal involved. It would be fun to do some yourself also and you can play a game together to match the classified ads with the right animals.

Write animal names on 3 x 5 index cards. Choose a varied assortment, such as

1. flying squirrel,
2. hedgehog,
3. orangutan,
4. vampire bat,
5. bison,
6. rat,
7. blue whale,
8. dingo,
9. llama,
10. aardvark,
11. snake,
12. walrus,
13. leopard,
14. dolphin,
15. duck,
16. weasel,
17. camel,
18. wart hog,
19. elephant,
20. ant,
21. salamander,
22. woodpecker,
23. earthworm,
24. spider,
25. trout,
26. fox,
27. cricket, and
28. crab

You could also use an assortment of endangered wildlife to increase your child's awareness of these animals, such as

1. Indiana bat,
2. Karner blue butterfly,
3. whooping crane,
4. bald eagle,
5. grizzly bear,
6. Canadian lynx,
7. Lear's macaw,
8. dwarf wedgemussel,
9. Florida panther,
10. Attwater's prairie chicken,
11. Utah prairie dogs,
12. Sonoran pronghorn,
13. chinook salmon,
14. Kemp's ridley sea turtle,
15. tiger,
16. arroyo toad,

17. desert tortoise,
18. golden-cheeked warbler,
19. humpback whale,
20. gray wolf, and
21. red-cockaded woodpecker

As you work to research each animal, introduce your child to various reference books and the Internet. If you choose endangered animals in the Keep the Wild Alive™ campaign, you can print information from the campaign's website (http://www.nwf.org/wildlife/) or use the site online. For each piece of information in her notes have your child write in the margins where she got it. It is important for children to learn to quote their sources early and to understand plagiarism.

As she writes a classified ad for a habitat that would appeal to each animal, have her consider the following: Where does it live? What type of food does it eat? What sort of material does it need, if any, to build its home? Does it like cold, hot, dry, or wet habitat? How about special requirements? Have her find a picture of each animal to refer to when writing the ad. Ads must include a description of where the animal finds food, water, shelter, and cover for raising young.

If you know a real estate agent, it might be interesting to meet with and interview that person and find out what it takes to write a detailed and persuasive ad.

When the ad text is finished, have your child write it carefully onto a 3x5 index card, one for each animal. You can then play a variety of different matching games with the animal names and their habitats. It would probably be best to make up an answer key before beginning to shuffle the cards up and play. You can play a memory game akin to Concentration, where all cards are laid flat on the table and appear to be identical. Each player turns over two cards and, if they are a match, gets to keep them. If not, the cards must be returned to their locations. Continue playing until all matches have been made – the person with the most sets wins! Or you can play cooperatively and work together to make the matches. Some ads might fit more than one animal so prepare to explain your matches if challenged.

You might want to extend this activity by having your child sketch a picture of each habitat to accompany the ad text. If she becomes very interested in one animal and would like to work more in-depth studying it, you could allow her to make a full 8 ½ by 11 (or larger) poster such as one which would hang in the window of a real estate office. There would be plenty of room on this for a catchy headline, persuasive text, and a nice picture of the habitat.

Note: this project is adapted from “Habitat For Sale”
http://www.nwf.org/nationalwildlifeweek/2000/habitat.html

Assessment Criteria

Content/declarative knowledge: how well does the student know the **content**?

Assess your child's work during introduction, activation, exploration, and extension components of the unit. Assess her independent skills review activities. For example,

- Can your child distinguish between instinctive and learned behaviors and give examples of each?
- Can she identify six animals which build, what they build, and the reasons why they do it?
- Can she explain what a force is and give an example of a force we experience in every day life?
- Has your child learned key points of factual information about each of the Animal Architects (such as those on the following sheet)?

Quality of the **product**: how well did the student present the work in writing, speaking, etc.

Assess the quality of your child's main lesson book work. For example,

- Did she concentrate on using her best handwriting and work diligently on her illustrations?
- Were her explanations clear and easy to follow?

Assess the quality of your child's Physics Journal. For example,

- Did she make notes on her process, observations, and conclusions as she proceeded through the scientific experiments?
- Did she make sketches during her animal observations and go back to them for reference when completing her main lesson book pages?
- Did she use the physics journal to gain a greater understanding of how physics is present all around her?

Quality of the **application**: how well did the student execute the knowledge application process?

Assess your child's cumulative project. For example,

- Did she demonstrate proficiency in reading both fiction and non-fiction texts to find specific information, draw conclusions, and support her answers?
- Did she demonstrate confidence in her ability to research independently?
- Did she demonstrate the ability to organize information into a summary?
- Did she learn to quote her sources and give credit for any ideas which were not her own/
- Did she demonstrate the ability to write persuasive text?
- Did she use the activities of this unit to gain a deeper respect for the animal kingdom and how humans are indebted to animals for many of the skills which we know?

Animal Architects – Key Points
Outline

Honey Bee
- the hexagon
- practice tile patterns with a variety of shapes
- why is the hexagon the strongest?

Spider
- starting to spin a web, looking for anchor points
- setting the overall shape
- getting closer together
- what forces does a spider web have to withstand?
  the wind, the spider running around on it, the struggles of prey
- various types of silk, sticky for prey, non-sticky for spider's path around perimeter

Ant Lion
- the shape of the trap
- luring in the ants
- how the funnel shape keeps it stable

Bird
- precise nests and sloppy nests
- lodging it in the tree, anchor points
- gathering materials, starting to build
- weaving for strength

Beaver
- what forces does a dam have to withstand?
  rushing water
- leaving steps for the fish to travel upstream
- construction of the lodge
- using mud as glue

Prairie Dog
- the plan of the prairie dog town
- adding fake entrances and exits
- building a tunnel which doesn't collapse on itself
  how do they do it? what forces does the tunnel have to be able to withstand?
- constructing connecting tunnels