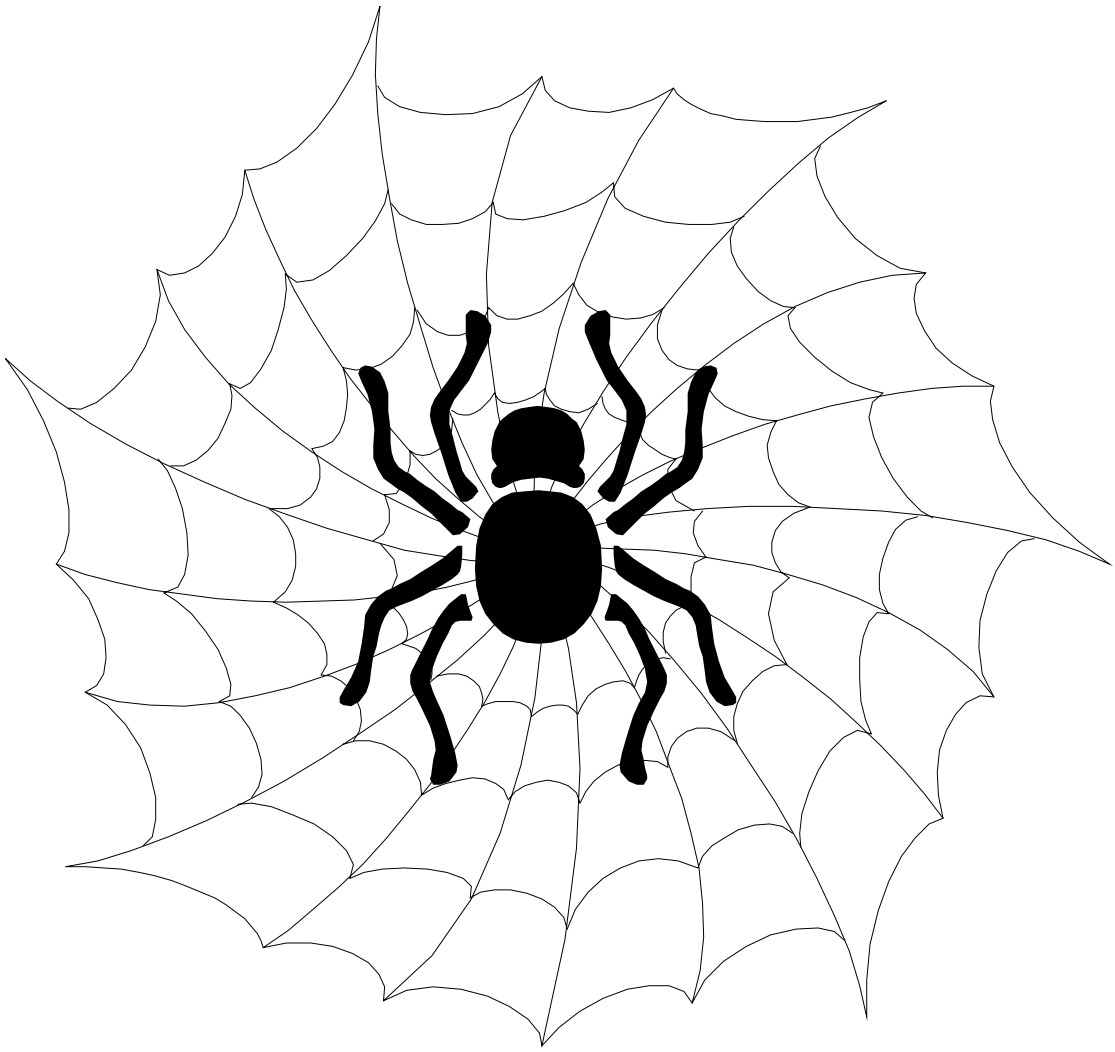

Spider Biology Unit

RET I 2000 and RET II 2002

Sally Horak
Cortland Junior Senior High School
Grade 7 Science

Support for Cornell Center for Materials Research is provided through NSF Grant DMR-0079992

Spider Biology Unit Overview

Grade level- 7th grade life science- heterogeneous classes

Theme- The theme of this unit is to understand the connection between form and function in living things and to investigate what humans can learn from other living things.

Schedule- projected time for this unit is 3 weeks

Outline-

*Activity- Unique spider facts
*PowerPoint presentation giving a general overview of the biology of spiders with specific examples of interest
*Lab- Spider observations
*Cross-discipline activity #1- Spider short story
*Activity- Web Spiders and Wandering spiders
*Project- create a 3-D model of a spider that is anatomically correct
*Project- research a specific spider and create a mini-book of information.
*Activity- Spider defense pantomime
*PowerPoint presentation on Spider Silk
*Lab- Fiber Strength and Elasticity
*Lab- Polymer Lab
*Project- Spider silk challenge

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Correlation to the NYS Intermediate Level Science Standards (Core Curriculum, Grades 5-8):

General Skills-

#1. Follow safety procedures in the classroom and laboratory.
#2. Safely and accurately use the following measurement tools- Metric ruler, triple beam balance
#3. Use appropriate units for measured or calculated values
#4. Recognize and analyze patterns and trends
#5. Classify objects according to an established scheme and a student-generated scheme.
#6 Develop and use a dichotomous key.
#7. Sequence events.

Living Environment Skills-

#1. Manipulate a compound microscope to view microscopic objects
#2. Determine the size of a microscope object, using a compound microscope
#6. Classify living things according to a student-generated scheme and an established one.
#9. Identify structure and function relationships in organisms

Standard 1. Analysis, Inquiry and Design. Scientific Inquiry- Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Analysis, Inquiry, and Design- Scientific Inquiry

Key idea 1- The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

S1.1 Formulate questions independently with the aid of references appropriate for guiding the search for explanations of everyday observations.

S1.1a formulate questions about natural phenomena
S1.1b identify appropriate references to investigate a question
S1.1c refine and clarify questions so that they are subject to scientific investigation

Key idea 2- Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

S2.1 Use conventional techniques and those of their own design to make further observations and refine their explanations, guided by a need for more information.

S2.1a demonstrate appropriate safety techniques
S2.1b conduct an experiment designed by others
S 2.1d use appropriate tools and conventional techniques to solve problems about the natural world, including : measuring, observing, describing, classifying, and sequencing

Key idea 3- The observations made while testing explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

S3.1 Design charts, tables and graphs, and other representations of observations in conventional and creative ways to help them address their research question or hypothesis.

S3.1a organize results, using appropriate graphs, diagrams, data tables, and other models To show relationships
S3.1b generate and use scales, create legends, and appropriately label axes

S3.2 Interpret the organized data to answer the research question or hypothesis or to gain insight into the problem.

S3.2a accurately describe the procedures used and the data gathered
S3.2b identify sources of error and the limitations of the data collected
S3.2c evaluate the original hypothesis in light of the data
S3.2d formulate and defend explanations and conclusions as they relate to scientific phenomena
S3.2f make predictions based on experimental data
S3.2g suggest improvements and recommendations for further studying
S3.2h use and interpret graphs and data tables

S3.3 Modify their personal understanding of phenomena based on evaluation of their hypothesis

Analysis, Inquiry and Design: Engineering Design

Key idea 1- Engineering design is an iterative process involving modeling and optimization; this process is used to develop technological solutions to problems within given constraints

T1.1 Identify needs and opportunities for technical solutions from an investigation of situations of general or social interest

T1.1a identify a scientific or human need that is subject to technological solution which applies scientific principles

T1.2 Locate and utilize a range of printed, electronic, and human information resources to obtain ideas.

Ti.2a use all available information systems for a preliminary search that addresses the need

Standard 2- Information Systems- Students will access, generate, process, and transfer information, using appropriate technologies

Key idea 1 Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.

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1.1 Use a range of equipment and software to integrate several forms of information in order to create good-quality audio, video, graphic, and text-based presentations.

1.3 Systematically obtain accurate and relevant information pertaining to a particular topic from a range of sources, including local and national media, libraries, museums, governmental agencies, industries and individuals.

Standard 4- The Living Environment- Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key idea 1 Living things are both similar to and different from each other and from non-living things.

Performance indicator 1.1 Compare and contrast the parts of plants, animals and one-celled organisms.

1.1g Multi-cellular animals often have similar organs and specialized systems for carrying out major life activities.

Key idea 3 Individual organisms and species over time.

Performance indicator 3.1 Describe sources of variation in organisms and their structures and relate the variation to survival.

3.1a The processes of sexual reproduction and mutation have given rise to a variety of traits within a species.

Performance indicator 3.2 Describe factors responsible for competition within species and the significance of that competition.

3.2a In all environments, organisms with similar needs may compete with one another for resources.

Key idea 4 The continuity of life is sustained through reproduction and development.

Performance indicator 4.3 Observe and describe developmental patterns in selected plants and animals.

4.3d Patterns of development vary among animals. In some species the young resemble the adults, while in others they do not. Some insects and amphibians undergo metamorphosis as they mature.

Key idea 5 Organisms maintain a dynamic equilibrium that sustains life.

Performance indicator 5.1 Compare the way a variety of living specimens carry out basic life functions and maintain dynamic equilibrium.

5.1a Animals and plants have a great variety of body plans and internal structures that contribute to their ability to maintain a balanced equilibrium.

5.1b An organism's overall body plan and its environment determine the way that the organism carries out the life processes.

5.1d The methods for obtaining nutrients vary among organisms. Consumers, such as animals, take in energy-rich foods.

5.1 e Carnivores obtain energy from animals.

5.1 f Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required for survival. Regulation includes a variety of nervous and hormonal feedback systems.

5.1g The survival of an organism depends on its ability to sense and respond to its external environment.

Standard 6- Interconnectedness: Common Themes- Students will understand the relationships and common themes that connect mathematics, science, an technology and apply the themes to these and other areas of learning.

Key idea 1- Systems Thinking- Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions

1.2 Describe the differences and similarities among engineering systems, natural systems, and social systems

Key idea 5- Patterns of Change- Identifying patterns of change is necessary for making predictions about future behavior and conditions.

5.2 Observe patterns of change in trends or cycles and make a prediction on what might happen in the future.

Standard 7- Interdisciplinary Problem Solving- Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Key idea 1-Connections- Interdisciplinary Problem Solving: Connections-The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design and inquiry into phenomena.

1.2 Make informed consumer decisions by seeking answers to appropriate questions about products, services, and systems; determining the cost/benefit and risk/benefit tradeoffs; and applying this knowledge to a potential purchase

1.3 Design solutions to real-world problems of general social interest related to home, school, or community using scientific experimentation to inform the solution and applying mathematical concepts and reasoning to assist in developing a solution.

Key idea 2-Strategies Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering an processing information; generating and analyzing ideas, realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

2.1 Students participate in an extended, culminating mathematics, science, and technology project.

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Name _____ Date _____
Unique Spider Facts Group ____

1. What is the longest leg span of a known spider? 1mm 10cm 25cm

2. Roasted tarantula tastes most like what? chicken nuts spicy

3. Can spiders regenerate new legs? Yes No

4. Can spiders camouflage as any of these? leaves bird droppings beehive

5. A male European house spider can run how many times its own body length? 3 33 330

6. What methods can spiders use to capture prey?
fishing lasso drop a net gummy spit attacking with other spiders

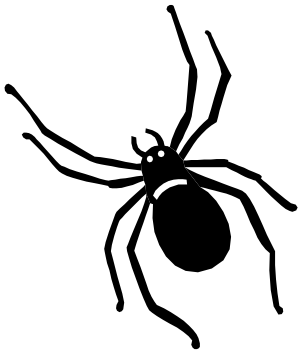
7. How long do scientists suspect that spiders been on the earth?
1600 years 210,000 years 380,000,000 years

8. Do all spiders have fangs? Yes No

9. Which are the closest relatives to spiders? mites insects scorpions

10. Do all spiders produce silk? Yes No

11. Male spiders are generally larger than females. Yes No



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Name _____Key_____ Date _____
Unique Spider Facts Group ____

1. What is the longest leg span of a known spider? 1mm 10cm <u>25cm</u>

2. Roasted tarantula tastes most like what? chicken <u>nuts</u> spicy
(in some South American cultures, people roast and eat tarantulas)

3. Can spiders regenerate new legs? <u>Yes</u> No
(a spider can cut its losses by breaking off its leg, a shut-off valve at the joint seals the wound, many re-grow new legs)

4. Can spiders camouflage as any of these? leaves <u>bird droppings</u> beehive

5. A male European house spider can run how many times its own body length? 3 33 <u>330</u>
(A European house spider can run 330 times its own body length in 10 seconds. If a person were to do the same thig, he would have to run more than six football fields in the same amount of time.)

6. What methods can spiders use to capture prey?
<u>fishing</u> <u>lasso</u> <u>drop a net</u> <u>gummy spit</u> attacking with other spiders

7. How long do scientists suspect that spiders been on the earth?
1600 years 210,000 years <u>380,000,000 years</u>

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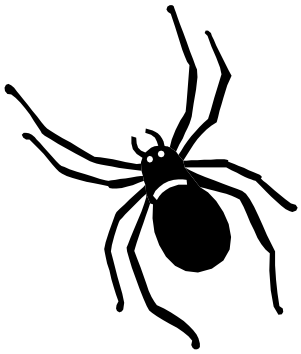

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PowerPoint Presentation- Spider Biology

I. Classification
- A. Kingdom
- B. Phylum
- C. Class
- D. Order
- E. Number of species

II. Anatomy
- F. Exoskeleton
  - Cephalothorax
  - Abdomen
- G. Eight legs
  - 7 parts
- H. Eyes and sensing
  - 1-4 pairs
  - simple eyes
- I. Spinnerets
  - Kinds of silk

III. Life processes
- J. Food-getting
  - Chelicerae
  - Pedipalps
- K. Growth
  - Molting
- L. Excretion
  - Malphigian tubules
- M. Respiration
  - Book lungs
  - Tracheal tubes
- N. Response
  - Feeding
  - Defense
  - Nocturnal
  - Camouflage
- O. Reproduction
- P. Movement
  - Open circulatory system
  - Haemocyanin
- Q. Secretion
  - Venom
  - Silk

IV. Other
- Q. Territory
- R. Evolution
- S. Arachne
- T. Navajo legend
- U. Safety
- V. Contribution
- W. Local spiders

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PowerPoint Presentation- The Biology of Spiders

I. Classification

A. Kingdom- Animal Kingdom (multi-cellular heterotrophs), related to mites, ticks and scorpians and less closely related to insects, millipedes, centipedes and crustaceans

B. Phylum- Arthropoda (jointed appendages with an exoskeleton) (some sources classify it as Superphylum Arthropoda and Phylum Chelicerata- unbranched appendages and lacking antennae)

C. Class- Arachnida (cephalothorax, exoskeleton, 8 legs), Two main groups- wandering and web builders

D. Order- Araneae, suborders-

Mesothelae-small, primitive, segmented abdomen, "living fossils", 40 species in Japan and Indonesia

Mygalomorphae- 2,000 species like tarantulas, trap-door spiders, purse-web spiders, some primitive characteristics such as 4 pairs of book lungs and chelicerae that strikes forward and down

Araneomorphae- 32,000 species (90%) 2 book lungs, and a tracheal tube for breathing, chelicerae work like pliers, many are ground hunters, silk used in many ways, true spiders

E. Number of species- 35,000-40,000 with probably 3X that yet to identify, 80% of all animals are insects while 8% are spiders

II. Anatomy

F. Exoskeleton- cephalothorax= fused head and thorax section that contains head, stomach and poison glands (digestive system) and central nervous system, abdomen= heart, respiratory organs, excretory and reproductive organs and silk glands, abdomen is soft and sac-like containing the 6 spinnerets, each spinneret contains many fine, hair-like tubes called spigots which produce a variety of threads, these spigots lead to several large silk glands in the abdomen, silk is formed as a liquid, as they are drawn out the proteins line up parallel to one another causing the silk to harden and form strong, elastic filaments, many threads fuse to form one stronger strand, spinnerets are believed to be shortened limbs that can move to place silk in precise locations when building a web or wrapping prey

G. Eight legs- have 7 joints, walk by means of flexors with fluid bags for extension(hydraulic action), 30 muscles to control movement, the seven segments are called coxa, trochanter, femur, patella, tibia, metatarsus and tarsus, the tips of the legs have 2 or 3 small claws used for climbing or grasping the silk, many ground spiders have claw tufts (scopulae) which are adhesive hairs to allow him to walk sure-footedly on smooth, or even vertical surfaces (or upside down on glass)

H. Eyes and sensing- generally poorer eyesight in web builders than in wanderers, do not require great sight as prey comes to them, smell and taste with legs, sense vibrations ("hear") and contact with hairs, vibrations can de discerned by spider to distinguish what is approaching

I. Spinnerets- have up to 6, 7 known kinds of silk, used for wrapping prey, egg sacs, dragline home, ballooning, snaring prey (spitting spider spits a net over prey) (ogre-faced spider are nocturnal and can catch prey in nets) (bola spider catches with a lasso), nursery, several types for web, spiders gently pull it out spinnerets with 2 hind legs, Linda Rayor "Their lives are tied to silk", several spigots yield silk in which proteins line up parallel to one another and solidify as it is drawn out of the spinneret, a web using 20 m of silk can weigh 1/1000g, webs are determined by the prey that is desired, usually build webs at night, about 30 minutes, some eat and some discard old webs

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III. Life processes

J. Food-getting- carnivorous, bites prey by injecting venom into it then vomits digestive enzymes into wound to liquify it, can wrap it, pre-digests with a drop of enzymes from their intestines than it sucks it down, "protein shakes," has filters in mouth so it does not ingest solids, repeats until consumed, diffuses from mid-gut into blood, can store nutrients for a long time so can go weeks or months without catching prey, usually eat insect but sometimes eat birds, frogs, fish and rodents, can be eaten by wasps and birds, chelicerae are its "pocketknife-like" jaws but can also be used to dig and carry small prey, pedipalps bear sensory organs, a few species eat pollen and nectar, some are cannibalistic

K. Growth- molts up to 12 times in a lifetime, the larger the spider the more the molts, the new one starts to form under old, the old one is digested and materials recycled, hangs upside down by a thread or on its back as heart speeds up and most of its blood is pumped to cephalothorax expanding it and rupturing it until exoskeleton splits and then uses muscular motions of the jaw to pull out of it, usually live less than a year though some survive 20 years (tarantula), smallest ones are less than 0.1mm, egg-larvae-young spider(nymph or spiderling)-adult, similar to incomplete metamorphosis

L. Excretion- Malphigian tublues secrete nitrogen wastes (guanates) passed to cloaca and to anus

M. Respiration- moist membranes in the abdomen called book lungs (2 pairs) though some they have one pair of book lungs and tracheal tubes like insects (more efficient, therefore more activity, less water loss)

N. Response- nocturnal, sophisticated sense of touch, hairs serve a purpose, can sense low frequency sounds and air movements, can smell and taste with hairs, 1-4 sets of simple eyes as needed to survive, eye arrangement and number is a means to identify the spider, diurnal spiders like the lynx and jumping spider have good vision at close range (10-20 cm), must distinguish prey from enemies, social behavior is limited to mating, otherwise they are solitary and anti-social , the spider-hunting wasp stings spider at junction between abdomen and cephalothorax paralyzing it then the wasp lays eggs and eats the spider, crab spiders can change color over 3 days to hide in flowers, Brazilian wandering spider has a neurotoxic venom, has supera-esophageal ganglia (considered the "brain") and sub-esophageal ganglia (directs locomotion), highly developed "brain" to adapt to changes in environment, some scientists believe that spiders can learn and have a memory searching endlessly for prey that has been snatched away, male makes a sperm web in which to deposit sperm and then pipette it up into palps, sperm stored in abdomen of female for weeks to months til the conditions are right, she fertilizes eggs just before they are deposited

O. Reproduction- become sexually mature after the last molt, courtship involves touching (American tarantula)-vibrations(wolf spider)-signal thread or dancing, females make pheromones to aid in courtship, organs found in abdomen in male and females, pedipalps are evolutionarily developed from legs possibly for sexual reproduction and food-getting, the palps serve as a sperm reservoir in the male much like a pipette, can pluck a strand on the web in the courting process, internal fertilization, the father is often eaten by the mother-to-be, within a few weeks she lays eggs in silk (a few dozen to several hundred), spiderlings hatch and silk lines will allow them to balloon into the air to get up to 100's of miles away, females are larger than males, females have large abdomens, males try to attract females without getting eaten, males are usually 100-1000's smaller than females, males try to sneak up on her so she doesn't know he is there, European nursery spider gives a wrapped "gift" of prey to mate, some sooth female then wrap her with silk to mate, red backs can mate with 5 males then eats them, females determine when is the best time to deposit eggs, lay 100's or 1000's of eggs, female wolf spiders attach cocoons to spinnerets and carry them around till they hatch then climbs on mother's back for a period of time, many male spiders die soon after mating

P. Movement-open circulatory system, hemolymph (blood) carries oxygen through body which has hemocyanin giving it a light blue color, has germ killing and blood clotting capabilities, legs have 30 muscles to manipulate it, slowed by their heart which is insufficient to allow walking and maintenance, ability to select silk strands that are non-sticky on which to climb

Q. Secretion- spider silk has some special properties sought after by scientists currently
glycerol acts as antifreeze so they can survive the winter, chitin for cephalothorax, venom, digestive enzymes

IV. Other

R. Territory- they have not found a way to survive in aquatic environments, some know social spider species in central Mexico and Costa Rico, found on mountaint tops and on islands on water's edge and at inter-tidal pools, Darwin noticed them 500 miles off the coast of South America, found thousands of them on the ship ballooning, some are the first on the scene after a volcano, European spider can capture air bubble and use it as a diving bell, one acre in England contained about 2.5 million spiders

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S. Evolution- evidence from 380mya, one of first terrestrial organisms, here before dinosaurs, were larger with segmented bodies unlike most today, well-preserved spider fossils have been found in NYS dating to the Devonian period 410-360mya, spinnerets and chelicerae are visible, some have been dated at 360-290mya (Carboniferous period) but few from Mesozoic Era(240-65mya), it is theorized that spider webs were irregular and near the ground, perhaps spiders influenced insect evolution by filling flying niche as spiders took prey at ground level

T. Arachne- the Greek goddess Arachne was a wonderful weaver who bragged that she could weave better than Athena the goddess of wisdom, though Athena won the weaving competition Athena turned her into a spider left to her weaving

U. Navajo legend- Spider woman who lived in a hole showed a Navajo woman how to weave and the Navajo have been weavers ever since, dream-catchers

V. Safety- Two poisonous kinds in US are black widow and brown recluse, clean the area, apply ice, contact medical facility for antivenin and treatment, characterized by two adjacent puncture wounds, 30 species in the world can cause harm to humans (Australian funnel-web spider, South American hunting spider), usually bit when they feel threatened except aggressive South American hunting spider

W. Contribution- control insect numbers, Linda Rayor "people haven't realized the importance of spiders in the ecosystem", they are a model organism because of their behavior, physiology and mechanisms, an old English saying says "If you want to live and thrive, let a spider run alive," spider's appearance and the fact that they lurk in dark places or dangle ominously from a thread give them a bad reputation, arachnophobia, human activity destroys habitat, pesticides kill spiders often, 16 spider species are on the threatened species list, certain tarantula species are overused for pet industry, spiders eat 100 kg (220 lb) per 2.5 acres of insects therefore a form of biological control

X. Local spiders-yellow sack spiders around here has a bite that affects humans- it is the most dangerous local spider, in US brown recluse in Texas/Arkansas, black widow in SW and hobo spider of Pacific NW

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Name _____ Spider Observations
Group_____ Date _____

Title- Spider Observations

Purpose- to identify the critical features of spiders

Materials-

dissecting microscope magnifying glass colored pencils
photos, preserved specimens or live, contained spiders

Procedure-

1. View several spider samples. Draw and color each.
2. Note observations of each in chart form.
3. In pairs, come up with features common to all samples.
4. As a class, draw and label the critical parts to all spiders.

Results- (create your own observation chart)

Conclusion-(draw and label a generic spider)

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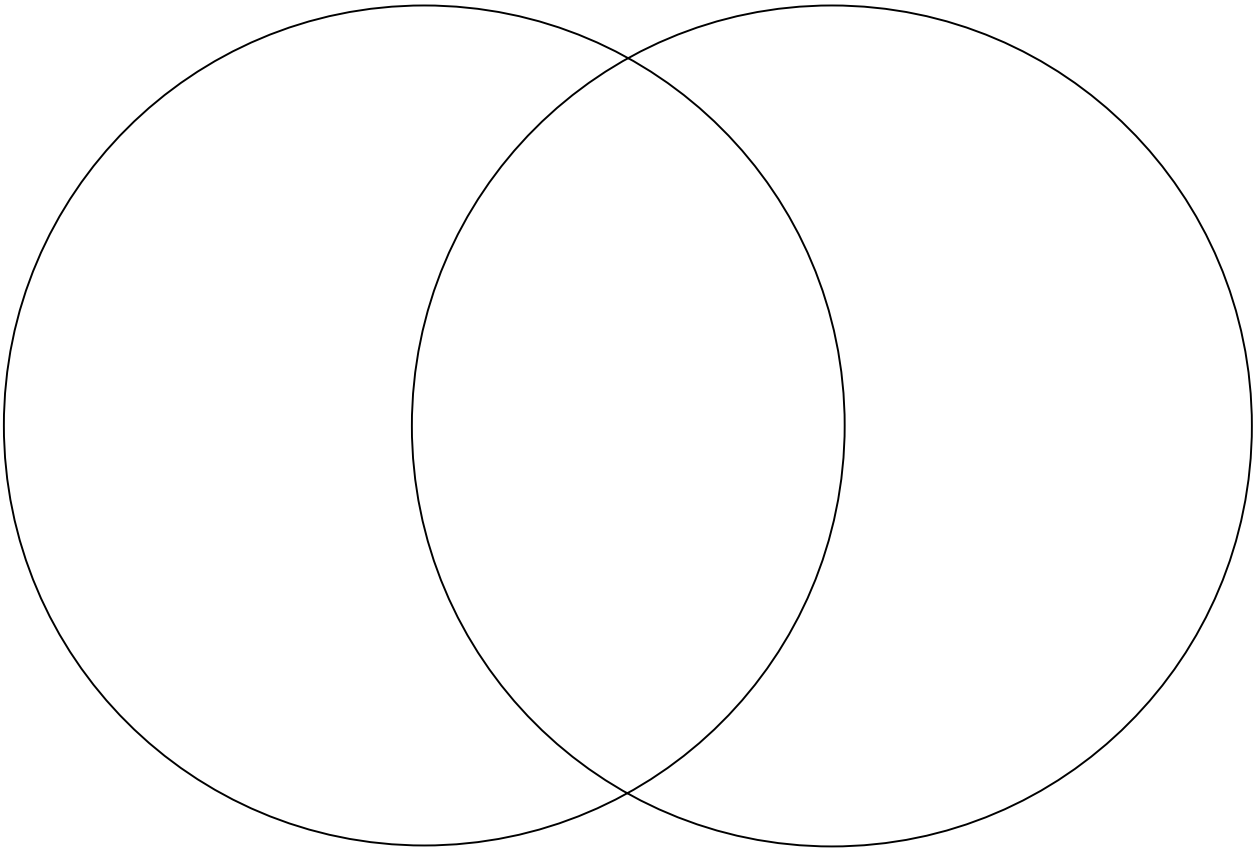
Name _____ Web vs. Wanderer
Group _____ Date _____

In the space below, after studying the list of characteristics of web spiders and wandering spiders, fill in the Venn diagram.
(From http:www.abcteach.com/Spider/compare.htm)

Web Builders	Wandering Spiders
make webs	do not make webs, crawl on the ground
tiny eyes, poor eyesight	good eyesight, 2 large front eyes
sensitive legs, good sense of touch	larger, powerful jaws
web-builders have 3 claws on each foot, middle claw holds silk	larger, sharp fangs
long, skinny legs to help them balance and glide over webs	wandering spiders have only 2 claws on each foot with a pad of hair between to help their grip
	hairy legs and bodies, hair sensitive and helps find prey



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Name _____ 3D Spider Model
Group _____ Date _____

Directions- Your job will be to find items at home to build an anatomically correct spider with the following parts:

Eyes (2-8)
pedipalps
chelicerae
cephalothorax
8 legs (attached to the cephalothorax)
abdomen
spinnerets

This model is due on _____

Collect some of the following to use to make your model:
detergent bottles straws toothpicks pipe cleaners
ping pong balls wire marshmallows gumdrops
popsicle sticks glue
and anything else you can think of to use!!!

Place this tag on your final project-

Name _____
Group _____
Date _____

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Name _____ **3D Spider Model**

Group _____ **Date** _____

Eyes....._____**10**
Pedipalps....._____**10**
Chelicerae....._____**10**
Cephalothorax....._____**15**
8 legs....._____**15**
Legs on cephalothorax....._____**10**
Abdomen....._____**10**
Spinnerets....._____**10**
Tag....._____**10**
Early bird special.....____**+10**

TOTAL SCORE = _____

Name _____ **3D Spider Model**

Group _____ **Date** _____

Eyes....._____**10**
Pedipalps....._____**10**
Chelicerae....._____**10**
Cephalothorax....._____**15**
8 legs....._____**15**
Legs on cephalothorax....._____**10**
Abdomen....._____**10**
Spinnerets....._____**10**
Tag....._____**10**
Early bird special.....____**+10**

TOTAL SCORE = _____

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Spiders in Literature

Read the short story entitled "The Finnegan" by Ray Bradbury from the book Quicker Than the Eye.

Research Ray Bradbury to learn in what genre he writes.

List five ways that this story reflects some information about spiders.

List five ways that this story stretches reality.

Some vocabulary to define:

-melancholy
-constabulary
-detritus
-bumbershoot
-manse
-rococo
-oblivion
-filched
-glade
-swards
-hillocks
-anthropomorphic
-excavates
-voracious

add three of your own words to define:

-
-
-

What do these terms mean in the story?

-"threesome and ten"
-"mysterious portal"
-"emptied of life"
-"waterproofs"
-"dustbin"
-"eight-legged, hide-and-seeker"
-"glom the scene"
-"unmarked crypt"

find three more quotes that you need to understand:

-
-
-

What symbolism do the doors represent?

How do you think Sir Robert died? Give two reasons why.

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Name _____ Spider Mini-book Project
Group _____ Date _____

Directions- This project will have you creating a small booklet that is quite professional! You need to do a rough draft and a final draft and do some research on a particular spider.

My spider is- _____
My rough draft is due on- _____
My final draft is due on- _____
I will need to bring these materials to class-
pen + pencil + ruler
colored pencils/markers/crayons
notes or internet print-outs on my spider

The booklet will be made from 3 pieces of white paper folded into a booklet.
The contents will be as follows, page by page:

1. Your name, date, group,
   Name of you spider, where it lives, how big it gets
2. Colored, labeled diagram of external parts
3. Colored, labeled diagram of internal parts
4. Food-getting of your spider- how it eats and what it eats
5. Growth- how it molts
6. Excretion- name the organs that help with this
7. Respiration- discuss how oxygen exchanged
8. Response- give examples of its responses
9. Reproduction- explain how this occurs, how many eggs
10. Movement- describe how it moves
11. Secretion- discuss the poison, silk and exoskeleton it secretes
12. Write 3 sentences or more about why spiders are so successful in surviving

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Suggested Spider Choices

Black widow
Daddy long legs
Brown recluse
Tarantula
Trapdoor spider
Funnelweb spider
Purseweb spider
Cobweb spider
American house spider
Sheetweb weaver
Golden orb weaver
Bolas spider
European water spider
Nursery web spider
Wolf spider
Giant crab spider
Jumping spider
Zebra spider
Ogre-faced spider
Pirate spider
Spitting spider

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Name _____ Spider Mini-Booklet Project
Group_____ Date _____

Rough Draft-	_____4	
In class participation-	_____4	
Page 1- heading, title-	_____2	
Page 2- External-	_____4	
Page 3- Internal-	_____4	
Page 4- F-	_____10	
Page 5- G-	_____10	
Page 6- E-	_____10	
Page 7- R-	_____10	
Page 8- R-	_____10	
Page 9- R-	_____10	
Page 10- M-	_____10	
Page 11- S-	_____10	
Page 12- Survival-	_____2	TOTAL SCORE= _____

Name _____ Spider Mini-Booklet Project
Group_____ Date _____

Rough Draft-	_____4	
In class participation-	_____4	
Page 1- heading, title-	_____2	
Page 2- External-	_____4	
Page 3- Internal-	_____4	
Page 4- F-	_____10	
Page 5- G-	_____10	
Page 6- E-	_____10	
Page 7- R-	_____10	
Page 8- R-	_____10	
Page 9- R-	_____10	
Page 10- M-	_____10	
Page 11- S-	_____10	
Page 12- Survival-	_____2	TOTAL SCORE= _____

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Spider Defense Pantomime

Directions: In groups of two to four, prepare a pantomime of one means by which a spider can defend himself to present to the class.

Mimicking

There are many species of spiders that take on the appearance and behavior of specific species of ants.They can use their first pairof legs to act as antennae. Ants are not sought after by birds and other predators.

Mutillid wasps cause a painful sting so some species of spiders mimic their appearance to avoid being eaten.

Camouflaging

Sand wolf spiders of genus *Arctosa* found in the US and Europe blend in perfectly with the sand on which they sit until they move.

Crab spiders like *Misumena vatia* can change color to the color of the flower upon which they sit.

The Trinidadian crab spider resembles a crinkled, yellowed leaf.

Vibrating web

Nephila spiders can set their webs in motion at such an oscillation as to create a visual blur to predators.

Hiding in a burrow underground

Cyclocosmia truncata found in Georgia, Tennessee and Alabama has an abdomen that is chopped off short and covered with a leathery shield with radiating grooves. This spider will cork its own tunnel with its abdomen.

Hunting spiders attack trapdoor spiders by finding the entrance and snipping the silken hinges and paralyzing the spider.

The brown wishbone spider from Australia builds two exits so if a predator attacks through one entrance it exits through the other.

Safety in numbers

Some species that have many predators and in response produce huge volumes of eggs.

Aggressive movements

The tarantula can lift their abdomens and scrape free, by vibrating its hind legs, a puff of abdominal hair which irritates the eyes and nose of mammals. These hairs can penetrate skin up to 2 mm.

The Sydney funnel web spider, *Atrax robustus*, has a severe bite in man. The females will release a glob of venom at the end of their fangs which deters its attackers.

Drag line get-away

Wasps can paralyze and kill spiders, so in defense a spider can drop to the ground quickly on its drag line.

Barrier web

The *Nephila clavipes* creates a barrier web on one or both sides of its web to alert it to birds and damselflies.

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Name _____ Date _____

Lab- Special Properties of Spider Silk Group ____

Title- (come up with your own creative title)_____

Purpose- the purpose of this lab is to research the physical qualities of spider Silk and test other fibers for strength and elasticity

Materials-

Compound microscope	Meter stick or ruler	2 Clips
Spider silk sample	Samples of nylon,	Ring stand
Paper, graph paper	cotton, jute,	Cup
Pencil , pen	silk, wire, wool	Paper clips
Colored pencils	rubber, hair	Triple beam
Microscope slide	stocking	Dissecting scope

Procedure-

I. Microscope Observations- Work in pairs. Draw the spider silk under low and high power. Draw in pencil, color, label in ink. Describe it in words. View human hair. Compare the two.

II. Spider Silk information.

Listen to Power Point on Spider Silk research and note the elasticity and strength of it. You will compare other fibers to this.

III. Elasticity and Strength Test

1. Work in groups of 4 with your samples to see how each stretches and if it goes back to its original size.
2. Take a piece of each fiber that is 10 cm long. Sample by sample, attach to the clamps. Note the level of the fiber at its lowest point on the ruler. Add one paper clip at a time and note the level with each addition. Add paper clips to the cup until it breaks.
3. Calculate elasticity by dividing the difference by the initial length and multiplying by 100 to get a percentage. Show work.
4. Collect data from all other groups by setting up a table.
5. Set up graph and plot all the data from each sample for each group.
6. Analyze the results on the graph.

IV. Brainstorming

In an open classroom forum, have each group report on the qualities most evident from their research. Then, gather ideas as to how this material could best be used to make something. Take notes on these ideas.

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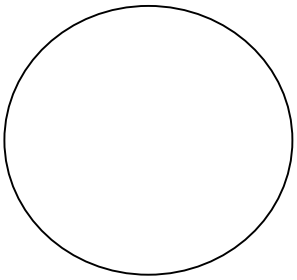
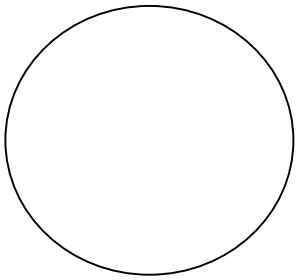
Results-

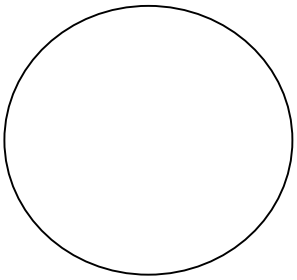
I. Microscope Observation

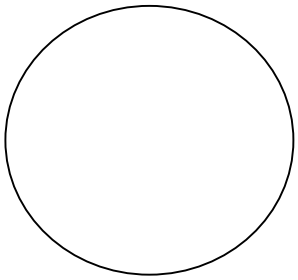
A. Draw spider silk under low and high power. Color. Label in ink.





B. Draw human hair under low and high power. Color. Label in ink.





C. In 2 sentences or more, compare spider silk with human hair.

II. Spider Silk Information- Take notes from PowerPoint presentation

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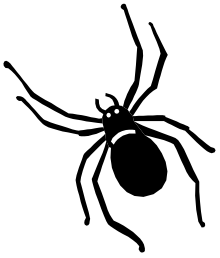
III. Elasticity and Strength Test

A. Make a data table for the un-stretched length and maximum stretched length and maximum weight it could handle without breaking. Include the weight of the cup and clamp, too. Use a ruler. Label using appropriate units.

B. Calculate the elasticity of each fiber. Show your work. Add this to your data table.



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C. Graph elasticity of each sample on separate paper. Use a ruler and color. Make a key. Plot elasticity percentage by sample.
D. Describe the information on the graph in your own words in two or more sentences.

E. Make a graph for the strength of each fiber. Plot total number of paper clips it held for each sample. Use ruler. Label with units.
F. Describe the information on the graph in your own words in two or more sentences.

IV. Brainstorming- What are the particular qualities of various fibers? What purpose do these qualities serve? What particular qualities does spider silk have? How might this biomaterial be useful? Keep track of the ideas mentioned in class. You will need this information!

Conclusion- Answer in full sentences.

1. Why would a spider need stretchy silk?
2. Why would a spider need strong silk?
3. Why would a spider need sticky silk?
4. How could the elasticity of spider silk be made into a usable product?
5. How could the strength of spider silk be used to make a product?

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PowerPoint on Spider Silk

I. The Best Spider for the Job

Nephila clavipes= the golden orb weaver
Found in southern states such as Florida
In Family Araneidae with 3500 species
Has tufts of hair on its legs
One of strongest silks comes from the golden orb spider
Its spider silk is the strongest natural fiber known (10 times)
Bite their prey and carry it to the middle of the web
Make huge webs of up to 39 inches which are used as fishing net
Can produce up to 1000 feet at once

II. Spider Silk

Chemical properties

It is a biopolymer- made of protein- mostly glycine and alanine
Called spidroin- molecular weight of 200,000-300,000- with regular orientation
It comes from spigots of spider spinnerets in a liquid form and hardens immediately- polymerizing as it comes out
It can be produced in aqueous solution at room temperature
It is not attacked by bacteria
It is very acidic

Physical properties

Almost as strong (or up to twice as strong) as Kevlar with 4 times the elasticity
Can stretch 25%-30% longer than its original length
It supercontracts (shrinks when wet)
It is stronger than steel- tensile strength of 300,000 pounds per square inch
Has one of the highest known energies to break of any known substance
Can stretch 25%-30% longer than its original length
It supercontracts (shrinks when wet)
It is stronger than steel- tensile strength of 300,000 pounds per square inch
Has one of the highest known energies to break of any known substance
A pencil thick strand of spider silk could stop a Boeing 747 in flight

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III. Potential Silk Production

"Bio-inspired materials are providing a new frontier for the fiber business," Lynn W. Jelinski (biophysicist at Cornell). "Someone's going to hit a home run in this field. But I am not sure yet who it will be."

The dragline silk has drawn the most attention from scientists for its strength, stretch and water resistance

Environmentally friendly

Also called BioSteel (by Nexia Technologies)

Attempts have been made to produce it in goat's milk, bacteria and plant cells (soy, tobacco and corn) as hosts

Dupont was working to produce 100-1000 lb. batches in order to produce batches of 1 million pounds. To be competitive it must sell at $12-$15 per pound. This appears to be on hold.

Scientists hope to also alter the color of the silk genetically

Possible uses in the future for spider silk

Automobile

*Super strong tires
*Seat belts material
*Rust-free panels for bumpers of cars
*Conveyor belt material

Medical

*Non-allergic surgical sutures
*Tissue repair (like skin, muscle, blood vessel)
*Artificial tendons or ligaments

Military

*All weather spacesuits
*Flak jackets (for soldiers and policemen- absorb bullets)
*Parachute material
*Climbing and bungee cord
*Body armor

Other

*Nets for fishing and other uses
*Wear resistant shoes
*Stockings for women

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Spider Silk is a Polymer, but what is a Polymer?

(adapted from
http://www.eecs.umich.edu/mathscience/funexperiments/agesubject/lessons/polymer.html)

I. Definition- a polymer is a chemical compound formed from long chains of the same molecule repeating and repeating and repeating.

II. Characteristics of polymers-
*They are stretchable
*They are not brittle, hard or rigid
*A stronger and more elastic polymer is made when there are cross-links in which its chains of molecules are connected in several places.
*Temperature affects the elasticity of some polymers.

III. Examples of Polymers
Natural- juice of rubber or aloe plant, spider silk
Man-made- plastic, styro-foam, chewing gum, latex paint

IV. Make a polymer
Materials- cup, stirrer, baggie, 20 ml water, 25 ml white glue, 1 tsp talcum powder, add 4 drops food coloring, 1 tsp borax solution (saturated water/borax solution)
Put water in cup. Add glue. Mix with stirrer. Add powder and mix 2 minutes. Add food coloring. Add borax solution. Stir 2 minutes. Remove from cup and place into baggie for storage. Store in refrigerator for longer life.

V. Questions for discussion
Does it have the characteristics of a polymer?
What could it be used for?
How does it bounce from different heights?
Does it react to cooling and warming?
What happens when it is left out to dry?

VI. Building Polymers
If time allows, build a polymer with gumdrops and toothpicks.

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Name _____ Date _____
Spider Silk Challenge Group _____

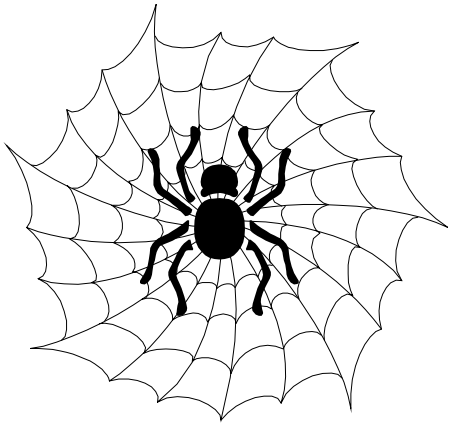
Option #1- AD- Now that you have learned about spider silk and tested other materials, you will apply your knowledge and select a useful product to manufacture from spider silk and create an advertising plan. Your audience will be a perspective company, sports team, the military or other specific group that will purchase your material for their product. Be convincing! Think of ways to SELL your brand new product!

Choose your method of advertisement

- Power Point presentation- 3-5 minutes, 5+ slides, research sited
- Videotaped commercial- 1-2 minutes, props and costumes, research sited
- Pamphlet- 4+ sides, color, word processed, research sited
- Poster- minimum 18" by 24", color, word processed, research sited

Option #2- STORY- You could write a science fiction short story of 500+ words or more if you choose. It should be word-processed after editing. Incorporate the facts from your research. Use planning sheet provided. (No Limits, pg 11)

Timeline- Computer lab time-_____
Classroom time- _____
Presentations on _____



Due date _____

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NAME _____ GROUP ____ DATE _____ *No Limits Worksh*

Short Story Plot Elements

Source (if any)
Record the headline or other source you are using to begin your plot construction.

What if?
What scientific idea will be explored by your story?

When will you set your story?
Now Near Future Far Future Past

Where will you set your story?
On Earth? Off Earth?

Any other details of setting? (For example, is it in your home town?)

What is the problem?
Based on your "What if?" decide the peril or difficulty your characters will face.

Who?

Who is/are your protagonists?

Who is the expert witness?

Who is/are the villain(s), if any?

Mood
Based on the problem and characters, decide what mood your story will have. For example, is it going to be funny or grim? (You may change your mind as you write.).

protagonist: def'n. the chief person in a story; the principal performer; the advocate or champion of a cause.

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NAME _____ AD/STORY PROJECT
GROUP____ DATE_____

PAMPHLET POSTER SCI-FI STORY OTHER_____

NAME-4……_____
DATE-3……_____
GROUP-3……_____
FOLLOWED DIRECTIONS-30……_____
CREATIVITY-30……_____
PROFESSIONAL LOOK-30……_____
TOTAL….____

NAME _____ AD/STORY PROJECT
GROUP____ DATE_____

PAMPHLET POSTER SCI-FI STORY OTHER_____

NAME-4……_____
DATE-3……_____
GROUP-3……_____
FOLLOWED DIRECTIONS-30……_____
CREATIVITY-30……_____
PROFESSIONAL LOOK-30……_____
TOTAL….____

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Resources

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Contact resources and Contributors

*Professor David Grubb, Faculty Advisor in Microscopy- discussions of spider silk
*Ken Finkelstein, Senior Research Associate, CHESS facility- discussion of spider silk
*Jen Gaudioso, Graduate Student- polymer model-making
*Emily Hackett, Graduate Student- polymer labs
Ivan Johnson, office computing manager for CCMR
*Professor Chris Ober- silly putty recipe
*Sven Pederson, Research Computing Facility- computer assistance
*Josh Pomeroy, Graduate Student- molecule building
*Dr.Linda Rayor, Assistant Professor, Arthropod Behavior
*R. Barry Robinson, Research Computing Facility- computer assistance
*Nev Singhota, CCMR Educational Outreach Coordinator- coordination and support
*Professor Robert Thorne, Physics Professor- how a spider walks
*Paul Urayama, Visiting Graduate Student- science fiction writing
*Pat Viele, Librarian of Physical Science Library- locating resources
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*David Newton, department chairman, Cortland JSHS, Cortland, NY. (until 7/02)
*David Darrow, department coordinator, Cortland JSHS, Cortland, NY (as of 8/02)

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