Class 1

Natural History

It is the **observation** of living plants and animals, and their interactions. Someone who looks at Natural History is called a **Naturalist**.

Animal Defences

Appearances

Camouflage is concealment, meaning the thing is hidden from the observer.

- **Background matching** is hiding by matching the surrounding area.
  - **Sparrows** have vertical lines on their body to help them blend into their background, such as meadowlands.
  - **American Bittern** camouflages using **Background Matching**
- **Crypsis** is hiding by not moving.
  - **Female Spruce Grouse** camouflages using **cryptic** AND **background matching**
  - **Eastern Screech Owl** uses **Crypsis** AND **Background matching**
- **Mimicry** is copying the background of something.
  - **Gray Tree Frog** camouflage by changing their color to match their background, and is a **Bark Mimic**
- **Seasonal Color** is changing an animal's color to match the appropriate season's background.
  - **Change Snowshoe Hares / Varying Hare** change from brown to white for winter, being pure white for winter, changing color to help them hide.

- **Disruptive Patterns** are patterns on the animal that breaks up an animal's body into parts, making it harder for predators to spot from a distance.
  - **Songbirds** have **eyelines / eye stripes** helping them hide for example in trees or certain plants. Helps them hide the part that is exposed when they are in their nest, it breaks up the bird's head, making it harder to spot from above the nest or at a distance.
  - **Kill Deer** have lines on their breast to hide them, again using **Disruptive Patterns**
  - **Canadian Goose** have a white spot near their neck so the head seems apart from the body, using **Disruptive Patterns**
- An **angle-winged butterfly** resembles a worn down leave. This is using the **shape of the body** to camouflage themselves.

Class 2

Masquerade (Type of Camouflage)

Camouflage does not work when you are not **cryptic**, i.e if the person is moving.

Being **Cryptic** means not moving, and not disrupting your camouflage.

Masquerade vs background matching: in background matching your color and your patterns match the background, whereas Masquerade is having the shape of the something or modifying the body to match the surroundings.

Shape can be used for **camouflage** too

Masquerade is changing the appearance to match the **environment** for camouflage, such as looking like a dead leaf, or a live leaf.

- **Dead Leaf Mimicry** is resembling dead leaves (using masquerade)
  - **Moths** do this
  - **Angle-winged butterflies** use their shape to resemble dead leaves for **camouflage**, there is also **mimicry** going on by mimicking the background (**dead leaf mimic**) this is can be called **Masquerade**
- **Live Leaf Mimicry** is resembling live leaves
  - A **Katydid** uses live leaf mimicry
  - **Luna Moths** hide up in the leaves, using live leaf mimicry
- **Twig Mimicry** is resembling twigs
  - **Inchworm** uses **Twig Mimicry** to resemble twigs to hide (form of Masquerade)
  - **Walking Stick** insect also uses Twig Mimicry
- **Thorn Mimicry** is resembling thorns on twigs and such
  - **Tree Hoppers** use **Thorn Mimicry**
- **Bird Dropping Mimicry** is resembling bird poop, animals tend not to eat bird poop
  - **Giant Swallowtail caterpillars** use **Bird Dropping Mimicry**
- Animals using their **surroundings** and putting their **surroundings** on them for **camouflage/masquerade**
  - **Camouflaged Loopers** use the surroundings (such as plants) to cover their body, hiding them from predators trying to find them.
  - **Spittle Bugs** generate a frothy wet **spit-like** material called **spittle** to hide themselves from predators
  - **Woolly Aphids** create **silk strains** on top of themselves to conceal themselves
  - **Scarlet Lily Leaf Beetles Larvae** (child form) coats itself with **feces (poop)** to conceal itself, making it seem like poop and less appetizing.

Bicolored Camouflage

Bicoloration offers background matching from two different surfaces (and two different sides)

- **Whirligig Beetles** are **bicolored** (black above and white below) to look like **sunshine** to predators **below water** and to look like water to predators **above water**

- **Backswimmers** are **bicolored** for the same purpose as **Whirligig Beetles**, but their colors are reversed, so they have to swim upside down to get the same defense as the **Whirligig Beetle.**
- **Countershading** and self-shadow concealment is using **bicoloration** to appear flat and blend in the background during sunshine (sun creating a shadow that casts down on the belly area)
    - **White tailed deer** are dark above and light below (**bicoloration**), this helps them be in open areas and appear flat during sunshine to blend in their background (using **Countershading**)

Camouflage is not failsafe. Many animals have plan B.

Startle Patterns are patterns shown to predators when **Camouflage** fails, to startle the predator and allow time for escape **(they have to be hidden)**

- **Sphinx Moth (Hawk moths)** open up their wings to scare the bird if it attacks, giving the moth time to fly away and escape.
- **Underwing Moth** also open up wings to show bright colors and to scare predators, allowing them to escape.
- **Hidden Eyespots** is having startle patterns in shape of eyes to scare the predator
    - **Polyphemus Moth** have eyes for startle patterns
- **Gray Tree Frogs** have bright yellow spots that flash when they leap as a **startle pattern**. This frog is a **bark mimic**,
- **Startle Structure** is a thing that comes out to startle
    - **Giant Swallowtail Caterpillars**, if touched on the head, will pop out bright red colored horns (called **Osmeterium**) that resemble a snake tongue.
- **Startle Sound** is a sound that startles
    - **Beavers** use their **tail slap** to cause a startle sound
    - **Ruffed Grouse** take off with an explosive sound caused by their wings to startle.

Eyespots (Always Visible)

Startle Patterns are hidden until needed, but not **Eyespots that are always visible,** this is to trick predators to believe the animals are bigger than they are. **Eyespots** are hence not startle patterns.

- **Eyed elator** have eyespots for the above
- **Eastern Tiger Swallowtail** have eyespots for the above

Class 3

Eyespots can be **startle patterns** if revealed suddenly, or in the case of eyes always being on the animal on display, make the animal appear larger than it is.

Distraction/Deflection Patterns

Startle patterns have a second function - to **deflect the attack** of the animal to a **non-vital** part.

- **Fake antennae / heads:**

- Some butterflies have 'tails' that look like the head of the animal to deflect the attack of the predator to a non-vital part of their body
    - **Hairstreak butterflies** have the tiny thick antenna (tail) to deflect the attack
    - **Canadian Tiger Swallowtail** butterflies have it as well
    - **Giant Swallowtail** have it as well
- **Autotomy** is having body parts that can be discarded and grown back, typically for distraction
    - **Five lined Skinks** have tails that disconnect upon contact and move around a few seconds to distract the predator, allowing the **skink** to escape (grows back, but not as long), this is **Autotomy**

Body Armor

Some animals have body armor for defense making it hard to bite into them and such

Hard Defenses

- **Millipedes (Narceus)** have body armor
- **Snails** have shells made of **Calcium** which is a form of body armor
- **Clams (Bivalves) (Calcium used to make shell)** have shells that protect them
- **Turtles** pull their heads inside their shells to protect themselves
    - **Blanding's Turtles** have the ability to party close their shells like a bridge, they can partly close the shell (both bottom and top sides)
    - **Snapping Turtles** snap (attack) for defense because they cannot pull themselves into their shell (hence being more aggressive)

Soft Defenses

- **Soft Hairs** is a defense where if the body is hairy, predators will avoid eating them
- **Hard Hairs (modified hairs)** are hairs that translate into hard spines
    - **Wooly Bears** have spines for hair, they roll up to protect themselves
    - **Porcupines** have **quills** that are modified hairs **(called guard hairs)**
        - **Porcupines CANNOT shoot these hairs contrary to popular belief**
- **Eastern Tent Caterpillars** make a big silk tent around themselves to protect them, they also have **hair** on their body because birds do not like eating hair.
- **Fall Webworm** also spin silk tents, they use this tent for defense and also for eating, the tent has leaves

Chemical Defenses

- **Poison Spines** are a chemical defense
    - **Io Moth Caterpillar** have poison spines
- **Aposematic Coloration (Warning Coloration)** is having bright coloration to warn predators that the animal is poisonous
    - **Milkweed Tussock Moth Caterpillar** are brightly colored
    - **Giant Leopard Moth Caterpillar,** if endangered will roll up and expose its poisonous brightly colored spines
    - **Yellowjacket Wasp**
    - **Red Eft** has poison in the skin
    - **Milkweed Beetle**

- **Striped Skunk** and **Porcupine** have **warning coloration** that works at night **(not bright)** as the are nighttime animals
- **Ladybugs** create their own poison from plants

- **Sequestering (to take)** is attaining chemicals (poison) from plants or other animals
  - **Monarch Caterpillar sequester** poison from **Milkweeds** by eating them
  - **Milkweed Tussock Caterpillars** also **sequester** the poison from the Milkweed
  - **Black Swallowtail Caterpillar** sequesters from Water Hemlock
  - **Photuris fireflies (are beetles) sequester** steroidal toxins
  - **Female Photuris fireflies** get their poison **from eating** male **Photinus Fireflies**
    - The process of copying the Photinus Firefly's pattern, this is called **Aggressive Mimicry** - it is making the body look different to attract prey in for eating usually.
- **Chemical defenses** can be released from different parts of the body
  - **Sawfly Larvae** release orally
  - **Blister Beetles** release bitter tasting **Cantharidin** (**terpenoid**) through their legs
  - **Yellowjacket Paper wasp** have injectors (stingers)
  - **Skunks** have sprayers, they spray **Sulphur Alcohol**
  - **Bombardier Beetle** create an explosion of hot gas that shoots out, and are brightly colored

Class 4

Aposematic Coloration are warning signs conveying - I'm dangerous, don't approach me. Typically found in insects, but also in some reptiles. Not with birds.

Mullerian Mimicry is copying the coloration of animals that are dangerous or poisonous **while being dangerous/poisonous yourself**

- **Milkweed Beetle and Milkweed Bug** have warning coloration (brightly red and black)
- **Monarch Caterpillar sequesters** poison from milkweeds. When this caterpillar becomes a butterfly, it also passes on the poison to the butterfly.
- **Viceroy Butterflies** are **Mullerian Mimics** and look alike with **Monarch Butterflies**

Batesian Mimicry is copying the coloration of animals that are dangerous or poisonous while **not** being **dangerous/poisonous yourself**

- It consists of a **Model** (the animal being mimicked) and the **Mimic** (animal mimicking)
- **Models** have to be more than **Mimics** otherwise predator wont stop eating species if most of species is ok
- **Hover Flies (Model)** resemble **Bumblebees/Wasps/Honey Bees/Bald-faced Hornet** (Models) yet the hover flies are harmless.
- **Sugar Maple Boar Beetle** looks like Yellowjacket Wasp (model)

Automimicry is the fact that animals of the same species resemble each other; the benefit of this is so if a predator has experienced a negative experience by eating one of the species, it will not go after other animals of that species.

Behavioural Defenses

Not all animals have warning colorations. You don't have to be brightly colored to be toxic.

- **American Toads** have the toxic **Bufotalin** yet is not brightly colored.
- **Bluffing;** Animals can inflate themselves to look larger, this is called **Bluffing**.
  - **Toads** do this.
  - **Hog-nose Snakes** also bluffs, it puffs up its head to scare predators.
- **Thanatosis:** animals playing dead to avoid predators that want to **kill them (not eat).**
  - **Hog-nose Snakes** also play dead, this is if the predator does not fall for bluff.
  - **Blister Beetles** also play dead (**Thanatosis**)
  - **Virginia Opossums** also play dead (**Thanatosis**)

Behavioural Group Defences is gathering in groups for protection. Safety in numbers.

- **White tailed deers yard, (are yarding)** means they gather together in large numbers

- **Birds** do the same thing as **Yarding**, it is called **Flocking.**
- **Aggressive Group Defenses;** Group Defences can also be aggressive
  - **Yellow Hornet Wasps** release an attack pheromone, so when one sees danger, it releases the pheromone and all come to attack
  - **Mobbing;** Smaller birds attack bigger birds by attacking them and then calling for more birds of the same pack. This is called **Mobbing**.
  - **Preemptive Striking;** Certain birds attack Owls in the morning so the Owls will leave by nighttime and those birds are safe. This is called **preemptive striking,** since it is planning ahead for the night.
- **Body Guards;** Animals protect themselves by using other animals as well
  - **Aphids** have **Carpenter Ants** as guards to protect them in exchange for sap.
- **Animals raise flags when escaping** that tell the predators / chasers that the animal has seen them and there is no point in pursuing them**,** or to tell other animals that there is a predator around.
  - **Eastern Cottontail** have a white tail that goes up when they run away
  - **White Tailed Deer** do this as well and have white tails.

Vigilance is animals being careful and looking out for danger. There are components that help to look out for this danger.

Components that help look out for danger:

- **Ears (Large external pianne)** capture sound
  - Rabbits, deer and other animals have **huge ears**. They magnify and capture sound. Which is why large ears are so important.
  - Ears can **pivot** to different direction to **scan** the area without moving the head.
  - **Beavers** have small ears, as with **big ears** they wouldn't be able to **swim**. So some animals cannot have big ears because of what they do.
  - **Tiger Moths** also have ears, but these are in form of membranes on the body (thorax) for hearing. They detect bat calls to escape by diving to the ground.

Class 5

Snakes

Snakes cannot hear and to compensate for this, have the **Jacob's Organ** which are special sensory cells in the roof of their mouth that analyze their tongue. There are two forks in the tongues; both forks analyze different things.

Olfactory Sense (Smell)

- Animals have **Jacobson's Organ** in their **snouts** which are sensory cells.
- **Flemen** is the posture assumed by animals to expose their **Jacobson's Organ**
  - **Moose** have enlarged snouts with sensory cells to analyze smells, called the **Jacobson's Organ.**
  - **Foxes** have **Jacobson's Organ**

Scanning Visually

- **Eyes on the side** of the head result in a 360 degree **superior field of vision**, but **inferior depth perception**.
- **Eyes on the front** of the head results in **superior depth perception**, typically on animals that hunt.
- **Eyes on the side make the view wide, eyes on the front help you hunt.**
- **Eye placement is affected by habitat**
    - **Beavers** eyes are near the top of their head line with their nose and ears so that it can remain submerged and show very little, so that they can see, hear and smell all at the same time while being protected
    - **Sandpipers** have their eyes placed in an odd location near the top part of their head, this is because they probe for food in the ground, so the need to see aboveground incase of a predator while they are probing for food in the ground.
        - **Wilson's Snipe**
        - **American Woodcock**
- **American Bittern freezes** when alarmed and puts its bill into the air, providing great background matching. This behaviour thereby affects the eye placement; its eyes are placed near the bill to see animals are coming towards it. But, it cannot see behind it, so it has to turn around to account for that
- **Large Eyes**
    - Animals that are night active have really big eyes as they gather more light
    - **Eyeshine** is the reflection in their eyes at night and is the white shine
    - **Tapetum lucidum** is a reflective layer that bounces back light that the sensory cells were unable to pick up, so that the sensory cells have another chance of picking them up.

        - **White tailed deer**
        - **Flying Squirrels**
- **More eyes** means **more protection**, this goes hand in hand with safety in numbers
    - Deers **yard** due to **safety in numbers** AND **more eyes**
    - Birds **flock** due to **safety in numbers** AND **more eyes**

Bird Flock Species

- **Single-species flock** is a flock of only one type of bird
    - **Sandpipers**
    - **Canada Geese**
    - **Waxwings (Important to know)**
- **Mixed-species flock** is a flock of multiple species of birds
    - **Black-throated Blue Warblers**
- **Flocks survive** by **not** having conflict amongst one another for gathering food
    - **Single species flocks** fly for food in large quantities so that the whole flock can eat without competing for the food.
    - **Mixed species flocks** extract different resources found in small quantities, little competition.

Plant Defences

Plants also have defences and also have predators, but unlike animals, they cannot move. They have to be more devious in the way they defend themselves.

Damaged Plant means that a plant has **lost a battle**
Healthy Plant means that the plant has **not yet lost a battle**

Physical Defenses

- **Constitutive Defenses** are defences that are always present.
- **Induced Defenses** are defences that are not **always** present.

Armor

- **Bark**
    - This is on trees that is a woody armor that protects trees from animals.
- **Hard Coats**
    - Seeds can be protected by hard coatings protecting them from being eating.
        - **Acorns**
- **Thorns**
    - **Thorns** are modified branches.
    - **Plants** can be protected from thorns or prickly coatings
        - **Thistles** are protected by thorns/prickly coatings.
    - **Prickles** are outgrowths on the skin of the plant, like hairs on the body.
        - Prickly Ash have **prickles**
        - New rose buds have **prickles**
    - **Hawthorn Plants** have thorns
- **Soft Hairs (Trichomes)**
    - **Trichomes** are soft hairs on the plant that only protect from **small animals,** for example making it harder for them to climb.
        - **Ragweed** has **Trichomes**

- **Glandular Trichomes** are **Trichomes** with chemicals that go into the system of the predator.
  - **Stinging Nettles** have them
- **Inducible** is the ability to **grow Trichomes** when **necessary** (meaning they do not always have them)
  - **Water Smartweed**

Digestibility Reducers

- **Structural Elements** make plants **hard to digest**
  - **Cellulose**
  - **Hemicellulose**
  - **Pectin**
  - **Lignin**
  - **Silica**
    - **Horsetails**
    - **Grasses**
- **Tannins** are a drying agent that make the animal's mouth dry when eaten. They are not **'Structural Elements'**
- **Calcium Oxalate Crystals** protect plants from predators and burn the mouth of predators
  - **Arum plants**
  - **Skunk Cabbage**
  - **Jack-in-the-pulpit Plant**

Chemical Defenses

- **Terpenoids** are a class of chemicals that **taste bitter** and **repel animals** and **do not contain** nitrogen
  - **Milkweed** have **cardiac glycosides** and thereby use **Terpenoids**
  - **Pine Cones** have **Resins** that are **Terpenoids**
  - **Poison Ivy** have **Resins** that are **Terpenoids**
- **Alkaloids** are a class of chemicals that make animals sick and **do contain nitrogen**
  - Are **Constitutive Defenses**
  - Interfere with the animal's **digestive system** so that food cannot be **dissolved** properly
    - **Asters**
    - **Buttercups**
  - **Hydrogen Cyanide** is a deadly poison that a plant cannot store **without killing itself.** They store this poison in leaves/separate components for predators to eat.
    - **Cherries**
    - **Bracken**

Wound Hormones are sent by **plant parts** to **other plant parts** when the plat is under attack. This allows communication between the parts of plants and allows the plant to get alerted of an attack so that it can start preparing its defences.

- **Potato** plants do this

Moulting Hormone helps the insect develop, this hormone stays with the insect in adulthood

- **Phytoecdysones;** Plants produce **Moulting Hormone** to cause rapid growth and as a result death for the insect.
    - **Ferns (Rock Polypody)**
    - **Bracken Fern**

Juvenile Hormone is only needed in the early stages of the insect's growth and must be stopped after pupil stage otherwise the insect **cannot grow to adulthood**

- **Phytoejuvenile**; Plants produce **Juvenile Hormone** to prevent animals from growing to adulthood and dying as a result.
    - **Balsam Fur**

Class 6

Plant Defences Cont.

Chemical Defenses

- **Animal Reproductive Hormones**
  - Plants can mess up the animal's ability to reproduce, by producing **Phytoestrogens**, and **stops bigger animals from reproducing**
- **Phototoxins; If animals consumes this,** the toxins **migrate to the skin** of the animal making their skin **highly vulnerable to UV damage**, causing animals to ultimately die.
- **Mustard Smell (Mustards)** is advertising the plant's toxicity
- Plants use **aposematic coloring (danger warning)** as well
  - **Fruit** have this; raw growing fruit has coloring to indicate it is not ready to eat

Phytohormones are used by the plant to get a response from the rest of the plant (plant parts communication)

Extrafloral nectaries is produced by some plants to entice ants to come to plant to defend the plant from other predators

Plants can call protectors (such as Wasps) and tell them that they are being attacked by caterpillars or other predators.

Environmental Stresses (Animals)

Sub-zero temperatures (extreme cold problem)
Biggest problem for animals and insects is that water turns to ice.
- Sometimes animals get stuck in frozen water, then water expands and kills them.

Cold-blooded (Ectotherme) Animals
Animals' internal temperatures are controlled by the outer temperatures.

Warm-blooded (Endotherms) Animals
Animals' internal temperatures **are not controlled** by the outer temperatures.

Dealing with Extreme Cold

Body Changes
- **Mammals** grow hair to protect themselves from the extreme cold
  - **Guard Hair (Outer Hair)** are the hair out on the animal, visible.
  - Under the **Guard Hair,** they have under fur that **traps body heat** for the mammal
- **Birds** grow bulkier feathers and have **Contour Feathers** on the outside and **Down** which is feathers underneath
- **Mammals (only)** have fat to warm themselves
  - **White fat** is on the body, to provide insulation, called **Subcutaneous Fat**
  - **Brown fat** is on the inside, for burning for warmth.
- **Birds** add **Subcutaneous Fat** as well, for fuel.
  - At night, they **Shiver** to burn up fat, providing the animal with heat. (**Thermogenesis**)

Gloger's Rule states that animals farther north are paler in coloration, suggesting there is a link between pale colors dealing with the cold better.
- Best color for warmth is **White,** this is because **pale colors retain heat better**
  - **Snowy Owls** are white
  - **Artic Foxes** are white
  - **Polar Bears** are white

Allen's Rule states that short extremities are better than longer extremities, as in the north, you find animals with smaller extremities.

Bergmann's Rule states that **Low Surface Area to Volume Ratio** and a **rotund (round)** shape is better for surviving in cold conditions; it helps with heat regeneration and retention
- Big Ears, Long Tails, and basically bigger extremities are not as great shapes for extreme cold.
- States that **rotund (round)** shapes are good for surviving cold conditions.

Animal Behavioural Features

Rete Mirabile (Countercurrent Heat Exchanger)
Typically found in ducks (or animals with webbed feet), this prevents the animal from losing heat from their bodies, as what the Rete Mirabile will do is cool down blood going down to the legs that are making contact with cold surfaces so that there is less heat loss.

- Ducks regulate the blood temperature that gets sent to its legs, so it will lower the temperature.

Tucking is when animals **tuck** their extremities **under** their feathers to keep them warm.

- **Swans** tuck their legs under their feathers to keep them warm.
- **Ducks** do this by standing on one leg and keeping the other leg under their feathers.

Counter-current vessels are found in some animal's noses that preheat the air before it goes to the body and lungs. Animals that use this keep their mouth closed and breathe through nose.

Shelters / Resting Spots

Roost Site is where **Birds** choose to sleep and is very important.

- **Coniferous Trees** are where most birds sleep, as any heat they lose is trapped by the tree, and when snow comes in it provides an insulating blanket.
- **Tree Cavities;** Animals go into small tree cavities to sleep.
    - **Woodpeckers** stay in cavities inside the tree overnight.
    - **Small Owls** do this as well
    - **Black capped chickadees, Voles and Flying Squirrels** gather in one cavity (per species) in **groups** to share body heat
- **Custom Shelter;** Some Animals build their own shelter
    - **Muskrat Lodges**
    - **Beaver Lodges**
        - **Beavers** add mud for insulation

Class 7

Subnivean layer is a layer underneath and is warm as the earth retains heat from the warm fall ground. This layer can be accessed **only** by **small animals**

- **Red Squirrels** go under the snow for this
- **Deer Mice** go under snow for this
- There are dangers however, such as animals suffocating at the surface as well as **predators** watching and listening for animals borrowing to attack.

Inside Snow; Certain Animals go inside snow to survive the winter

- **Ruffed Grouse Snow Bed; Ruffed grouse** dive into the snow to spend the night, they create a little snow cavern to keep them warm, called a **Snow Bed.**

Basking in the sun is using the early morning sunlight to absorb solar energy for warmth

- Early in the morning, **birds** will come out to absorb the solar energy and using the sun to warm themselves up

Torpor is a state of deep sleep animals enter where they **reduce** their **heart rate and body temperature** in order to conserve energy

- **Black-capped chickadees** enter **Torpor**
    - Even though in Torpor, Birds still **shiver** for heat as it is **thermogenesis**

Ectotherms Survival

Ectotherms are animals that do not generate their own body heat and **cannot** afford to be out in sub-zero temperatures **at all.**

- **Snakes** are ectotherms; they cannot be out in sub-zero temperatures.

Frostline is the level at which the frost affects the ground. It is a few degrees above 0

Behavioural Freeze Avoidance is avoiding freezing by going below the **Frostline** to the ground that is warm (few degrees above 0) to prevent animal from freezing

- **Animals** that go below the **Frostline**
  - **Snakes** go below the **Frostline** to prevent getting frozen and become **dormant**
    - **Hibernaculum** is a group of **Snakes dormanting** (being dormant) together
  - **American Toads** dig below the **frost line** using **behavioural avoidance**
  - **Many Salamanders** dig below the **frost line** as well
- **Animals** that go to the bottom of ponds/lakes
  - **All** adults and **most** Baby / Hatchling **turtles** avoid freezing by going to the bottom in the ponds and lakes
  - **Many** frogs do the same as turtles by going to the bottom in ponds

Insects Survival Above Frostline

Ootheca is a special cover that protects insects' eggs during the winter, this allows adult insects to die and still exist when winter ends

- **Cryoprotectants (protect - life) are chemicals that protect an animal**
  - They modify the temperature the animal can go down to (so animals can survive very low temperatures)

- **Glycerol** is used as a form of antifreeze used in the **Ootheca** to protect the animal

Walking Sticks eggs' also survive the winter by being covered by **Capitulum,** a substance ants like to eat.

- Ants will take these eggs to their nest, eat the **Capitulum** and then dispose of the leftover eggs
- These leftover eggs that are disposed of remain **in the nest protected** and hence hatch unharmed

Supercool is when no ice forms inside the body of the animal. This is usually due to the animal using a form of anti-freeze.

Insects directly surviving winter

Pupal cases and **cocoons** keep the dormant insect from contacting water/ice, protecting them from the cold

- **Silk Moths** survive the winter in **Pupae stage**

Wooly Bear Caterpillars remain in the **caterpillar** stage all winter long and survive by having a **Cryoprotectant (Glycerol)**.

Female Mosquitoes survive the winter as **adults** by stopping eating in the fall, ridding themselves of any liquid, and use a form of anti-freeze

Angle-winged Butterflies survive overwinter as **supercooled adults,** and this is why these butterflies are one of the first things we see each spring

Freeze Tolerance is the ability of allowing ice to form without killing the animal. Ice is formed **between** the cells but not **inside** the cells.

- **Golden Fly Grub** allows ice to form in non-vital areas.

Freeze Tolerant Animals (Freeze Tolerance) are Animals that can survive freezing.

Some Herps (reptiles such as frogs) freeze completely during the winter and survive

- They are obviously **Freeze Tolerant**
- **Gray Tree Frogs** freeze
- **Wood Frogs** freeze

- **Spring Peepers** freeze
- **Chorus Frogs** freeze

Goldenrod Gall Fly grubs survive inside **Golden Rods (Special Location).**

- **Goldenrod Flies** lay their eggs on Goldenrod stems.
- Their eggs are coated with a special coating that makes the plant grow around the egg
- **Goldenrod Gall** is the circle (abnormal growth) that grows around the egg and is what the **grub** lives in, and is used for food
  - **Galls** are plant swellings
- The **Grubs** are protected internally as well and are **Freeze Tolerant**
  - They have **Cryoprotectants** (primarily **Glycerol**).
  - Between the cells are non-vital spots called **Ice Nucleating Sites** that can afford being frozen and **attract** ice, allowing the **Grub** control over where ice is formed

Snapping Turtles do not **supercool** and are not **freeze tolerant,** instead, they go down to bottom of ponds/lakes and **absorb oxygen through their skin.**

- **Hatchling Snapping Turtles** head towards water to survive the winter.

Some **Hatchling Painted Turtles** are **freeze tolerant (not adults) <u>before</u>** they exit the den they hatched in, allowing them to freeze. **But once they have left,** they are **no longer freeze tolerant** and have to go to water like the rest.

<u>Endotherms Survival</u>

Endotherms (Warm Blooded) are animals that cannot freeze. Some do survive winter by becoming **dormant.**

Animals become **Lethargic** (not Torpor/Hibernation)

- **Racoons** undergo periods of **Lethargy**
- **Porcupines** go under their dens being **Lethargic** as well

Animals that undergo **light periods** of **Torpor (Hibernation)**

- **Chipmunks** undergo partial periods of **Hibernation**, they retain a low heartbeat and low temperature but awaken every few days

- **Bats** undergo partial periods of Torpor as well, lowering their body temperature but not lowering their heart rate so that they can move to warmer parts of their caves easily.
- **Black Bears** retain very **low heart beats (7 beats per minute),** but have a **very high body temperature** and are easily awoken.
    - They **do not shit or piss** during this period, they have a plug in their rectum that stops them **from shitting** called a **Tappen**
    - They are **still fat** when they come out in **spring** because they rely on their fat as there is not a lot of food for them in the start on spring
    - **Black Bears** climb **Beech Trees** to eat **Beech Nuts**

Animals that undergo **True Hibernation**

- **Groundhogs** have their heartbeat go down to near zero **as well** as their body temperature goes near zero. **World's largest true hibernators.**
- **Jumping Mice** are also true/deep hibernators

Class 8

Mobility (Snow)

Physical adaptations

- **Tall Legs** help traveling through deep snow
    - **Moose** have very tall legs to get into deep snow and travel
- **Larger Surface Area** helps walking on top of snow, like snow shoes
    - **Larger Hind Feet;** Certain Animals have larger hind feet to act like snowshoes
        - **Snowshoe Hares** have huge hind feet giving the animal **large surface area** of feet
        - **Fishers/Martens** have very large hind feet
    - **Ruffed Grouse** grow **scales** on the side of each toe giving them a **larger surface area**, these scales wear down by the summer and grow back in the fall

Behavioural Adaptations

- **Subnivean Space** also solves the mobility problem as it is easier to move around there, so that solves mobility problems for small animals that reside there.
- **White-tailed Deer** gather and **yard.**
  - They remain in areas with less snow and more food
  - Use tracks of other deers to help getting around
  - **Browse Line** identifies where **White-tailed Deer feed i**n winter
- **Breaking the Trail** is touching a part of the snow trail the **first time**, making it easier for others to touch that same spot.
  - **Wolves** often walk in **single file**, putting their feet exactly where the one ahead has, taking advantage of the trail being broken by the previous wolf
- **Tabagoanning** is when the animal have long bodies that they use to slide on their bellies to travel
  - **Otters** have this
  - **Minks** have this

Migration (Animals that do not stay and escape sub-zero temperatures)

Not all animals stay to face the challenges of winter and instead escape sub-zero temperatures.

- **Geese** migrate
- **Red Bats** migrate
- **Common Green Darner Dragonflies** migrate
- **Monarch Butterflies** migrate to **Mexico** and then to mountains
- **Insect-gleaning** (that feed on insects) **Songbirds** migrate due to lack of food supply as the major issue rather than temperature.

Bird Migration

- **White Fat** is the **Power Supply** for birds
- **Half of birds** that migrate **die.**

Birds that migrate great **Distances**

- **Scarlet Tanagers** fly to Brazil
- **Artic Tern, ex-World champion Migrator (20,000 KM each year)**
- **Red Knot, World champion Migrators, (26,700 KM each year)**

Bird Migration Time

- **Nighttime Migration**
  - Reasons for migrating during the night
    - It is **Calmer** at night (in terms of wind)
    - It is **Cooler** (decreasing the chances of dehydration)
    - There are **fewer** Predators
  - Most **Songbirds** migrate **only** at **night**
- **Daytime Migration**
  - Usually, **predatory birds** migrate during the **day** and they face challenges in terms of energy expenditure
    - **Thermals** are air currents
    - **Soaring** is using the air current to move instead of flapping a bird's wings
    - **Slotted Feathers** gives the bird **extra lift**
    - **Thermal Hopping** is using **Thermals** as springs to glide up and down so that birds can travel without expending much energy**.** This allows the birds to fly longer distances with little fuel, but, this **needs sunshine**.
      - **Bald Eagles**
      - **Turkey Vultures**
  - **Swallows** are fast fliers and burn up a lot of fuel, as a result they feed on flying insects to replenish fuel.
  - **Hummingbirds migrate** as soon as the plants begin to disappear as they need these plants while **migrating** to replenish fuel.
- **Full Time Migration** (Migrating 24/7)
  - **Red Knots** migrate 24/7, their record is **8000** km in 6 days non stop.

Migration Navigation

- **Daytime Migrants** navigate using the **sun**, landforms and other visual cues
- **Nighttime Migrants** navigate using the **moon**, and constellation stars
- Both **Daytime** and **Nighttime Migrants** use the **Earth's Magnetic Field**
- **Birds,** both daytime and nighttime migrants, use the **Earth's Magnetic Field** to navigate
  - **Rhodopsin** is a retinal photopigment that is *probably* involved in their GPS.

Migration Group Position (Custom Title)

- **Geese** fly in a v-shape to **conserve energy,** by getting a **free lift** from the goose in front. That **free lift** is created when the air hits and leaves the wing of the goose that is in front.

Banding is putting a little band on the bird, typically on the foot, with a number, revealing a lot of secrets of **migration** to us.

- **Mist Nets** are used to capture Birds for banding
- **Geolocators** are used to provide good migration data

Class 9

Plant Survival In The Winter

Some plants have parts that die off, and the main part lives under the snow where it is not as cold as above (similar to animals).

- **Cold Hardy** is the plant world's version of animal's **Freeze Tolerance**, allowing the plant or plant part to survive the dominant cold temperature in the area, as ice is formed **between** cells and **not inside** cells
- The main parts of the plant that live under the snow also need to become **Cold Hardy (need to acclimate).**
- **Acclimation** is the process of becoming **Cold Hardy** and can be broken down into two stages
    - **First** stage is triggering by a change in the **photoperiod**
        - **Photoperiod** is a ratio between daylight and darkness (day duration)
        - **Phytochromes** are sensors that react to a change in the **photoperiod**, allowing the plant to begin preparation for **acclimation.**
        - Cells begin to go **Dormant**
    - **Second** stage is triggered by not below zero, but still, cold temperatures, that causes the plant membranes to begin preparing for the cold temperature.
- In order to become **Cold Hardy,** and **acclimate,** the plants experience the following
    - **Antifreeze** components are added
    - **Water** in the **exposed** parts (such as leaves and twigs) that stay above the snow is evaporated to prevent the exposed part from freezing.

- Cells have their **water drawn out** (removed) to increase their **solute concentration**, which results in their freezing point to be **lower** and their membranes more flexible
- Plants **allow ice to form** between the cells but there is a **membrane** that **prevents** water from flowing inside the cell, saving it from the water freeze issue.

Plants use **chlorophyll** to use sun's energy to **create heat** during the winter.

Trees and plants that **retain needles** during the winter are vulnerable to be damaged by **solar radiation.**

- To cope with this, they create **xanthophyll pigments** to protect themselves

Skunk Cabbage is a plant that heats up in early spring so that it melts the snow around itself

- Some **insects** hide inside this plant to use the heat it creates, during the winter

Desiccation is another problem that causes plant parts to **dry up** during **sunny days**, and they prevent this from occurring by utilizing various methods such as

- Having a **small surface area** (smaller parts)
  - **Confers Trees** retain their leaves so size and shape is important for them
  - **Evergreen Trees** are green year round and their surface area is big, so to cope for that fact, they curl up to achieve a **small surface area**
    - **Rock Polypody** are **evergreen** (fern)
    - **Conifers Trees** are evergreen (tree)
  - **Deciduous Trees** have a **large surface area** and **lose their leaves** during winter to achieve a **small surface area,** this is called **Deciduous (Shedding of Leaves).**
- Closing their **stomata** (allows air and gas going in/out) so that water **cannot escape**
- Have **waxy cuticles** that prevent the plant from being dried
- Having **hairs** on the **underside** that help to retain moisture on the leaves and break up the wind that dries the plant up.

Red Maple trees are trees that have leaves that come in two colors, **red** and **yellow**

- This is because the colors represent genders.
  - **Male** Trees turn **red**
  - **Female** Trees leaves turn **yellow**

Weight of snow is a problem as it might break branches or parts of the tree

- **Conifers** retain their leaves during winter, and since the leaves are smaller, this helps them with the weight
- **Shapes** also help some trees shed snow
  - **Short branches** with **small needles**
  - **Spire** shape is the shape of a christmas tree (thin and tall at the top and fatter as you go down)
    - **Balsum Fur**

- **Spindly** shape is the tree being very skinny and parts of the leaves being clumped on parts of it
  - **Black Spruce**
- **Shapes:** http://i59.tinypic.com/16bzms9.jpg

Survival in Excessive Heat

Plants Survival in Excessive Heat

Plants face a problem in the heat as well

- Excessive Heat can cause **Desiccation (Drying out)**
  - Like in the winter, to prevent **Desiccation** the idea is to have a **small surface area**
  - Plants reduce their **leaf surface area** by **curling** their leaves (like in the winter)
  - They also **close** their **stomata** (like in the winter as well)

Animal Survival in Excessive Heat

- Animals can move to **shady areas** and site for shade
- Animals (non-insects) can go into **water** where it is cool
  - **Insects** use alternative strategies for cooling as they cannot go into water
    - They **shunt** (move) the blood down to parts of the body with **larger surface area** (long abdomen for example**)**
    - **Obelisk** is a position that **Dragonflies** assume where they point their **abdomen** towards the sun to prevent it from heating up by the sun hitting it, and to provide shade to the other important parts of the body
    - **Stilting** is a position that **Tiger Beetles** assume where they stand tall on their legs to protect their body from the hot surface below
- **Evaporative Cooling** is evaporating the **warm water** inside and making the air that the animal breathes cooler
  - **Bees** rub liquid on their bodies that evaporates**,** using **Evaporative Cooling**
  - **Turkey Vultures** pee **(**excrete) on their legs so that it evaporates**,** using **Evaporative Cooling**
  - **Panting** is a form of **Evaporative Cooling**
    - **Foxes** do this
    - **Birds** do this
- **Ducks bypass** the **Rete Mirabile** (used to conserve heat) and more blood is **shunted** to extremities
- **Beavers bypass** the **Rete Mirabile** and **shunt** more warm blood to their **tail** because it has a **larger surface area**

- **Honeybees** are **Social Insects,** they gather together and use their wings to cool the hive down
- **Hyperthermia** is a **dangerous strategy** where animals allow their internal temperature raise above the normal temperature to lose more body heat and cool down
    - **Mourning Doves** use a **dangerous strategy** and allow their internal temperature to rise to **45 degrees (1 more degree and they die)**

Nutrition

Plants can **make their own food** but their challenge is finding raw materials to generate that food

Animals get their nutrients from
- Eating **plants**
- Eating **other Animals**

Herbivory is the action of animals eating plants
- **Maple Spindle Gall Mites** eat leaves

Detritivore is an animal that eats **dead** plant material
- **Millipedes** eat **pine pollen**

Nectar is hidden in a special part in the flower that requires something special to be accessed
- **Long Proboscis (tongue)** are used by some insects to get **nectar**
- **Long Beaks** are sometimes required to get **nectar,** and there are certain plants that have nectar hidden very deep, requiring certain types of animals to get nectar
    - **Hummingbirds** have **long beaks** and also **long tongues**
        - They have a **Hyoid Apparatus** that allows the tongue to be **extensible**

Sap is in plants that is inside the plant, requiring some sort of **stabbing** to occur to get the **sap**
- Bugs have parts that probe the plants called **Stylets** to **poke** the plant and get the sugars
    - **Aphids** do this and are **sucking bugs**

Filter Feeders are animals that collect **nutrients** found in water, and this is how to get their nutrition, thereby having “food **delivered** to them”
- Animals that **Filter Feed** typically do not move much
- **Clams** are **Filter Feeders,** they filter the nutrients out of the water that comes to them
- **Baby Black Flies** are **Filter Feeders,** and they feed using little brushes on their head called **Lateral Brushes** that **open up** to gather material coming in, and then **close** to eat material that came in.
- **Dabblers** or **Puddle Ducks dabble** in the water to gather things using their large bills, the water goes out and the nutrients are left in

- **Lamellae** are little bristle brushes that capture the food material that is in the water (helping to filter feed
  - **Swan**
  - **Mallard**
- **Tongues** also help **filter food** and **capture** nutrients and food from the water

Class 10

Nutrition (Cont.)

Animals face issues when eating plants because of **Tough Structural Components** in leaves, and need to break these down in order to process them and get their nutrients.
This process can be broken down into two categories

Ingestion (Getting food into their mouth)

- **Radula** is a sharp component, like a chainsaw, with teeth that come out to process plant tissues.
  - **Slugs** and **Snails** have **radulas**
- **Mandibles** are **Modified Mouthparts** that are used to cut apart plant tissues.
  - **Caterpillars** have **Mandibles** to cut apart plant tissues
  - **Leaf blotch miners** are **caterpillars** that live **inside the leaf** and eat leaves from the **inside**
- **Modified Teeth** are teeth that have been modified to be used to eat plant material
  - **Incisors** are **modified teeth**
    - **Incisors** self-sharpen
    - **Beavers** have **Incisors** and their teeth are **orange** because they are **full** of **iron**
    - **Moose** only have lower **incisors,** and use the upper part of their mouth, which is extremely hard, to hold in place branches/leaves so they can then use their lower **incisors** to pull the branches/leaves off.
  - **Cheek-teeth** are **modified teeth** that grind and process food
    - **Masseters** are muscles that power the **Cheek-teeth**
    - **Moose** have **cheek teeth** they use to process food before it is eaten.
- **Analogous Structures** are components of animals that have the same function but different origins and structures
  - **Radula**, **Mandibles** and **Cheek-teeth** are **analogous** as all perform the same function but have different structures/origins
- **Gizzard** is the tool **Birds** use to break hard structures into smaller pieces as they have no teeth
  - **Ruffed Grouse** have **Gizzards**
  - **Gizzards** can grind amazing hard substances such as broken glass, razors and nails
  - **Grit** are small stones that **birds** swallow to help break down food, helping with the **Gizzard**

END OF MIDTERM COVERAGE

Digestion (Processing Food Internally)

Digestive Enzymes are used to **digest** food, but **most** animals are unable to produce them.

- **Slugs/Snails** are some **animals** that produce **Digestive Enzymes**

Caterpillars do not produce **digestive enzymes** and hence waste a lot of nutrition in their food.

- However, they can afford to do this as they have a **vast amount of food** for them to consume.

Animals such as **Moose** and **Deer** get the help of **bacteria** to digest their food.

- This is called a **Symbiotic** relationship between the **bacteria** and the **moose**.

Rumination is the process of re-chewing food by bringing food back into the mouth, breaking up hard plant tissues/walls.

- **Ruminant** is an animal that performs **rumination.**
- **Rumen** is the chamber where bacteria live that that help digest food
- **Moose**, **Cows** and **Deer** have **rumens.**

Caecum (plural **Caeca)** is the chamber that **bacteria** live in for animals that do not have a **rumen**.

- **Rabbit** have it
- **Beavers** have it
- **Geese** have it

Coprophagy is an animal processing food twice by eating its own droppings, usually due to a lack of a **rumen**

- **Rabbits** do this.
- **Beavers** do this

Huge Digestive Tract is what animals without a **rumen** or **coprophagy** have to help them digest food

- **Porcupines** have a **huge digestive tract**

Fruit as a Source of Food
A lot of animals use fruit as a food source, some as their only source and others incorporate them.

Waxwings are **fruit eating specialists**

Seed Dispersers are animals that eat plants/fruits and poop out seeds thereby helping the chances of growth of those plants/fruits' and are not interested in the seeds.
- They have **large gapes** (mouth opening) for fast **ingestion**
- They have **short intestines** for fast **digestion**

Seed Predators are animals that eat seeds only, throwing away the flesh of the plant/fruit
- **Crossed Bills** are special bills that are crossed (not straight)
  - **Red Crossbills** eat pine cones and use their **crossed bill** to open the scales of the cones to get to their seeds.
  - **Crossed Bills** have difficulty getting grit, this is the negative
- **Incisors** are used to get to the seed
  - **Red Squirrels** use their **incisors** to get pinecone seeds
  - **Chipmunks** use their **incisors** to get acorn seeds
- **American Goldfinches** have **tiny bills** so that they can access **thistle** seeds.
- **Blue jays** use their bills as hammers by hitting acorns with it to get to the seed.
- **Evening Grosbeak** do this.

Animals dealing with Plant Chemical Defences
Herbivores need to come up with strategies protecting them from poison or damage from poisonous plants. (i.e a plant with **chemical defences)**

MFOs are special enzymes that neutralize toxins of plants and allow herbivores to eat the plant without being harmed

Vein Drain is a process used by herbivores that **sequester** poison from plants, they control the flow of poison the plant transfers by cutting the veins that transfer poison in the plant, **sequestering** the little amount of poison the plant then produces.

Seasonal Diets

Moose switch their diets, eating foods **high in** sodium during the **summer**, storing it in their rumen, and then eating foods **low in** sodium during the **winter**.
- Leaves and Twigs are very low in sodium, which is what the moose eats during winter
- Road Water/Mud in the spring is where they get their sodium during the spring.
- **Water-shield** is an aquatic plant that contains 500x more sodium than land plants, and is what the moose eats during the summer

Class 11

Animals Eating Other Animals (Predation)

Advantages of eating animals over plants
- Higher level of **protein**
- Easier to **digest**

Disadvantages of eating animals over plants
- Can be hard to **find** and hard to catch
- Harder to catch and well **protected**
- They **fight** back

Predation is the act of animals eating other animals.
- The first stage of this is **locating** the prey
- The second stage is **capturing** the prey
- The final stage is **immobilizing (killing)** the prey

Hawks are birds that hunt during the **daytime**
- They have **Sharp Vision**
  - They have **large eyes** that collect light for better responsiveness
  - They have a large number of **Cones** that help with **sharp vision**
  - They have **Large Eyes** that are able to magnify their vision **by 2 to 3 times (important; this is widely exaggerated to be much more)**
  - Eyes are placed on the **front** for depth perception, giving them a better idea of how far they have to jump/dive to get to their prey

Owls are birds that hunt during the **nighttime.**

Visual Hunters are animals that hunt dependent on their vision
- **Jumping Spiders** have some of the best vision in spiders, and are unique in that they can **change** their field of vision **without** moving their eyes and are **Visual Hunters**
- **Crab Spiders** are also **Visual Hunters**

<u>Finding Prey</u>

Vision

Large Eyes are beneficial, and give more light.

- **Frogs** have big eyes for hunting
- **Glycogen Rich Rods** make their eyes more light-sensitive

Frontal Placement of eyes gives more depth perception, but as a drawback, the animal does not have vision behind their head

- **Compound Eyes** use many pieces to create a **single** image that the insect sees
  - **Tiger Beetles** have this, and hunt during the day.
  - **Dragonflies** have this as well.
- **Simple Eyes** means non-**compound eyes**
  - **Spiders** have 8 **simple eyes**
- **Whirligigs** have special eyes that can see above and below water at the **same** time because their eyes are half **above** water and half **below** the water
- **Ground Beetles** hunt during the night

Hearing

Large Pinnae (Ears) magnify sound for animals

- **Wolves** have big ears.

Owls have no **external** pinnae **(**ears**)** but hear very well with their faces.

- **Facial Disks** capture sound and direct sound to their ears hidden under their fur
  - **Gray Tree Owls** do this
- **Wide head** and **Asymmetrical (**non-symmetric**)** ear positioning of the Owls help them to hear and pinpoint sound.

Echolocation is bouncing **ultrasound** (frequency humans cannot hear) off things to get a better image of what the thing is

- **Bats** use **Echolocation (**bouncing sound off things and animals) to get a better image of what is there.
- **Shrews** also use **Echolocation (TODO: Make group for Echolocation)**

Smell (Olfactory Sense)

Elongated Snout (Longer Nose) helps with analyzation of smell

- **Vomeronasal Organ (Already seen earlier)**
- **Flemen (Already seen earlier)**
- **Scent Trails** are easier to follow at dusk.
- **Snakes** use the **Jacobson's Organ (seen earlier)**

Touch (Tactile), tactile meaning the sense of touch

Touch sensitive front paws are front paws that have a lot of sensory cells used to analyze the thing they are touching

- **Raccoon's** paws have them

Vibrissae (Whiskers) are on many mammals and help them find prey

- **Otters** have them

- **Foxes** have them

Rictal Bristles are hair-like feathers near the mouth of some birds that help them find prey.

Eimer's Organ is what **Star-nosed Moles** have in their **Nose Protuberances** (the fingers on the nose) which gives them a 3D-like picture of their surroundings, very detailed.

Herbst Corpuscles are sensory cells that react to pressure and give the animal information on what it is they are touching.

- **Sandpipers** have **Herbst Corpuscles** in the tip of their bills.
- **Ducks** have **Herbst Corpuscles too.**
- **Woodpeckers** have **Herbst Corpuscles** in the tip of their tongues.

Rattlesnakes have **infrared** heat sensors that notify them of what is in their vision, and can detect the slightest change in temperature (Heat Detection)

Capturing Prey

Active Searching is actively searching for prey

- **Foxes** do this
- **Spiders** do this
- **Tiger Beetles** also search and capture

Animals that **wait** for their prey to come to them

- **Prey Mantis**
- **Most Owls**
- **Crab Spiders**
    - **Crab Spiders** can change colors

Class 12

Capturing Prey (Cont.)

Traps

Flight Intercept traps are meant to trap flying animals.

- Some spider webs are **Flight Intercept Traps**
- **Orb-weaver spiders** weave orb-shape webs

Argiope spiders have webs that they use as **Flight Intercept Traps**

- They have a **Stabilimentum** on their webs that is a highly visible silk on the **middle** of the web.
- This silk emits UV patterns that plants do, attracting insects by making them think it is a plant
- Spider's **body** also has that same UV pattern, aiding in the masquerade of a plant.

Pitfall traps are traps made in the ground, in a form of a 'pit'

- **Ant-lion larvae** hide in pits, buried in, and wait for ants to appear to eat them.
- **Mole-tunnels** can be considered as a **pitfall** trap, if prey falls in, it will eat them.

Aggressive Mimicry is using the body to look like something to attract prey

- **Alligator Snapping Turtle** open their mouth and use their tongues to look like worms that fish are lured to and eaten
- **Angler Fish** has an appendage on its head that is used to attract fish to eat.

Funnel Weaver Spiders build webs on the ground, targetting things that would step on them.

Sheet-web Spiders create webs consisting of two components; **sharp edges** for insects to trip and fall down in the sticky **second** component, the **bowl.**

Spider Webs Facts

- Spider Webs are **Hygroscopic** meaning they absorb moisture.
- Webs can contain **6 or more** types of silk
- Spiders can **recycle silk** from broken webs

<u>Mouth</u>

Most **mammals** have **canines** for hunting.

Golden Eagles have a **Meathook** tip (their beak is in the form of a hook.)

Mergansers (Ducks) have long narrow beaks with **serrated edges** (like serrated edges of a knife) to catch fitch

Otters are **canines** that help them eat and capture fish

Tiger Beetles use modified **mandibles** for capturing their prey.

Tongues

Animals have **extensible tongue** that they use to capture and eat prey

- **Frogs** perform a **Tongue Flick** to capture prey, which is the action of flicking their long tongue out to capture prey.
- **Woodpeckers** tongues are **extremely long;** it rolls up all way near its eye.
  - **Hyoid Horns** is what shoot the tongue out and extend it.

Legs

Some **spiders** do **not** use webs and instead use their legs to capture prey

- **Crab Spiders** hide on flowers, using their legs to capture prey
- **Jumping Spiders** use their legs to capture prey

Raptorial Legs are the **Praying Mantids** legs that they use to capture prety with.

Birds have **Talons** that are strong toes used to capture prey

- **Bird Hawks** kill with their talons and are common hawks that attack mourning doves and sparrows.
- **Osprey Hawks** have special feet for catching fish
  - They have **scales** on the underside of their toes to help grab slippery fish.
  - They have a **reversible outer toe** that may help them pierce the fish better when hunting
  - **Owls** also have a **reversible toe** that help them capture their prey too

Killing Prey

Mouth

Temporalis power **Canines** for the lethal bites to kill prey.

Shake and Break is shaking prey to break its neck and kill it

- **Foxes** use this techniques

Slash and Shock is slashing prey up and shocking it by bites, eventually bleeding the animal to death, used on larger animals

- **Wolves** use this technique against **Moose**

Weasels bite into the **cranium** (brain case) to kill their prey.

Cats bite into the **neck** vertebrae.

Larger birds of prey kill with their **Raptorial Bill (Predatory Bill).**

Shrikes kill with their bill and also use their bill to carry prey (they have weak legs).

Some **Snakes swallow** their prey whole while it is **alive**

Constrictors are snakes that kill the animals by suffocating them, when the prey exhales (reducing their body size), they tighten their grip, and continue this until the prey dies

- **Gray Rat Snakes** are **Constrictors**
- **Milk Snakes** are **Constrictors**

Injected Toxins

Injected Toxins contain **digestive enzymes** that break prey down into liquid and is used by predators

- **Massasauga Rattlesnake** have **poisonous** bites and inject **Venom** into prey
- **Crab Spiders** also use **injected toxins**
- **Robber Flies** also use **injected toxins**
- **Short-tailed Shrews** also use **injected toxins**

Selective Feeding are **predators** that only eat certain parts of their prey, leaving indigestible parts behind

- **Predatory Insects** that kill the prey will usually not eat everything of the animal; they slurp what they need.
- **Predatory Birds** pluck off fur and indigestible stuff and then eat the meat underneath.
- **Fishers skin porcupines** before eating them, removing the meat from underneath the skin with spines.
- **Wolves** can eat small bones, but avoid **big** bones, and pass indigestible pieces through their body by wrapping that part with hair first.
- **Owls** swallow their prey **whole**, and they cough out **pellets** that contain the prey's bones that could not be digested.

Predator Challenges

Predators have their own set of problems and drawbacks.

Bioaccumulation is ingesting toxins **indirectly** through the prey a predator has eaten.

Botulism is a syndrome of **bioaccumulation;** birds eat fish from contaminated waters, and they die due to **bioaccumulation** from the fish.

- **Peregrine Falcons** were driven near extinction due to DDT poisoning. The **bioaccumulation** resulted in thinner eggs and made them more clumsy as they would knock off their eggs by mistake from their nests, killing the eggs

Human Prejudice is the killing of **predatory animals** due to fear that these animals are dangerous/scary.

- **Coyotes** are killed year-round.
- **Friendly fire** is the idea that humans began killing for some good purpose, for example humans began killing wolves in the hopes that the caribou population will increase.

Starvation is the main reason **predators** die and the biggest challenge they face.

Predators play a role in **natural selection** where sick animals are killed first.

Class 13

Host is the animal that the organism (parasitoid) is currently in.

Ovipositor is an egg-laying apparatus that female insects have and use to inject eggs in a **host.**

Parasitoids are animals that eat their **hosts** from the inside and **kill** the **host.**

- **Braconid Wasps Larvae** feed on caterpillars, they begin emerging out of the host caterpillar when in pupa state.
- **Tachinid Flies Larvae** are **parasitoids.**
- **Flesh Flies Larvae** are **parasitoids.**

Insects Laying Parasitoids

Many insects lay parasitoids on other insects, which means laying their eggs on them.

Thread-waisted Wasps paralyze **caterpillars** and take them to their borough, and then lay their eggs on the caterpillar. The **caterpillar** ultimately dies, once the eggs hatch.

- **Spider Wasps** do this with **spiders**

Cerceris is a **digger wasp** that first digs a hole, spends a night in the hole, and then brings in beetles and lay their eggs in there, in the hole.

Parasitoid Insects Finding a Host

Visual Scanning is simply searching for a right **host** visually.

Megarhyssa Ichneumon wasps have very long **ovipositors** that they use to drill in tree barks, looking for fly grubs to lay eggs on. They sense the larvae by smell and vibrations.

Pelecinid Wasps lay eggs on **June Beetle Grubs** in the ground by digging in the ground

Some wasps lay their eggs inside **golden grub galls,** inside the fly larvae surviving the winter there.

Snapping Turtle Eggs get **parasitoid** eggs laid on them by wandering flies that lay their eggs **when** the snapping turtles are laying their eggs.

Parasites are animals that feed on the **host** but do **not** kill the **host.**

Obligate Parasites are parasites that **only** feed on blood
- **Leeches** are **obligate parasites**
- **Ticks** are **obligate parasites**

Anticoagulants are enzymes injected by parasites that prevent blood from clotting (keeping the blood flow continuous)

Ectoparasites are **parasites** that live on the **outside** of the host.
- **Leeches** are **ectoparasites** in all stages
- **Moose Ticks** are ticks that are found in the winter on a **moose**
  - **Engorged (Pregnant) Female Moose Ticks** leave the moose to lay their eggs, and later climb on coming mooses again to continue the cycle.
- **Lyme Disease** can be caused to humans by ticks feeding off on humans.
- **Arrenurus** are **aquatic mites** attach to children dragonflies, and transfer to the adult dragonfly.
- **Ectoparasitic Flies** are flies that attach onto animals
  - **Flat Flies** are flies that attach onto **birds**
  - **Bat Flies** are flies that attach onto **bats**
- **Glochidium** is an **ectoparasite** on a fish's gills and fins
  - **Baby Clams** are **Glochidium**

- **Pocketbook Clams** opens up their shells and show a **Mantle** that looks like a fish, attracting other fish and, when the fish is close, spews its children near the fish to be inhaled through the gills.

Haller's organ is an organ that detects temperature changes, and tracks down a possible **host** by the **host's breath.**

Class 14

Remaining On The Host

Claws can be used to grip the skin

- **Flat flies** have **claws** that grab onto the skin of the **host.**

Mouthparts can be used to penetrate and hold on to the **host.**

- **Leech** have slicing/dicing mouth parts that cut the skin open and begin sucking the blood and sucking on to the skin (attaching themselves)
- **Hypostome** is a mouthpart that **Ticks** have that has **barbs** that will clutch onto the skin preventing the mouthpart from leaving the **host.**

Problems with **Ectoparasites**

- They face a problem of the **host** dying, which will cause them to die as well most likely
- They face a problem of being removed by the **host**
  - **Foxes** scratch themselves, and can remove the **ectoparasite**
  - **Birds** groom and preen their feathers, and this process can remove the **ectoparasite**
  - **Pectinate Toe** is a special grooming claw **Herons** have that can possibly remove **ectoparasites**
  - **Beavers** have a **double/split** toenail on each foot that they use for grooming that can possible remove **ectoparasites**
    - **No one** really knows how they use it

Endoparasites are parasites that live **inside the host**

Endoparasites often transition through hosts

- **Definitive Hosts** are the end host for a parasite
  - **Deers** are the **definitive hosts** for **Brainworms**
- **Intermediate Hosts** are **not** end hosts for a parasite but are a host in the middle
  - **Snails** and **Slugs** are **intermediate hosts** for **Brainworm Larvae**

Parasitic Castration is changing the behaviour of the **host chemically,** removing the sexual hormones of host, so removing the sex drive of the **host** basically, reducing risk of being killed.

Cuterebras are **Bot Flies** that are **endoparasitic** only in the larval stage, and are commonly found in **mice** and **squirrels**

- **Female Bot Flies** eggs hatch from the heat of an animal walking on the ground, the hatched larvae then shoot themselves onto the animal, attempting to enter through any hole.
- The **Larva**, once it has entered the the animal, makes a hole in the stomach so that it can breath.

Brainworms live inside a **Deer** and have an interesting life cycle

- **Definitive Host: Deer,** the brainworm live inside the brain of the **deer.**
  - They have no negative effect on the deer and their eggs exit the deer along with the deer's poop, so that it is consumed by a **snail** or **slug** as an **intermediate host.**
- **Intermediate Host: Snails / Slugs,** they ingest the larvae by eating **deer** droppings.

    - The **larvae** alters the behaviour of the snail and makes it a daytime feeder, thereby having more chances of being eaten by a **deer** through leaves.
    - The **larvae** travels to the **deer's** brain through its stomach to its brain through the spine.
- **Brainworms** have no effect on their **definitive host (**the deer**)** but can critically injure a **Moose**
    - They damage the spine while making their way into the brain, and eventually **kill** the **Moose.**

Fluke Flatworms

- **Definitive Host: Robins**, they leave the **robin** through its poop
- **Intermediate Host: Aquatic Snails**, they alter the snail's tentacles, making them very colorful to lure **Robins** into eating them

Problems with Endoparasites

- **Host** dying
- **Intermediate Host** isn't found
- Wrong **Host** is entered, thereby killing the host by mistake

Scavengers are animals that feeding on dead animals.

Facultative scavengers are part-time **scavengers**

- **Eagles** are **facultative scavengers**
- **Gulls** are **facultative scavengers**
- **Ravens** are **facultative scavengers**

Obligate Scavengers are full-time **scavengers**

- **Turkey Vultures** are **obligate scavengers** and have **adaptations** for **scavenging**
    - They have **non-separated** nostrils
    - They have a large **olfactory bulb** in their brain that converts blood into a smell the vulture they looks for.
    - They have a **raptorial bill** for ripping apart meat
    - They are **bald** to prevent blood/dirty material from getting stuck onto their head
    - They soar very low and slow in order to better smell odors
- **Blow Fly Maggots/Larvae** are **obligate scavengers,** the adult **blow fly** lays its eggs on the dead animal and then the maggot/larvae eats feeds on the dead animal

Necrophagous means eating the flesh of a dead animal

- **Burying Beetles / Carrion Beetles** are **Necrophagous** and are beetles that drag animals down to the ground.
    - Female **Carrion Beetles** will attract male **carrion beetles** and both will climb inside the dead animal to move the dead animal in the ground.
    - The **larvae** of the **burying beetles** are **obligate scavengers,** not the **burying beetles.**

Predictable Food Shortages are food shortages that are expected by animals so they plan ahead of time.

Animals have **solutions** to **predictable food shortages**

- **Dormancy / Hibernation**
- **Migration**

Unpredictable Food Shortages are food shortages that are not expected - the food fluctuates year by year, and is inconsistent.

- **Nuts** are **unpredictable food shortages**
- **Berries** are **unpredictable food shortages**
- **Small Mammals** are **unpredictable food shortages**

Animals have **solutions** to **unpredictable food shortages**

- **Irruptive/Nomadic** means an eruption of animals; meaning normally there is a small number or none, but then an amazing number appears the next time.
    - **Bohemian Waxwings** are fruit specialists and move to areas with large fruit crops and thereby are **Irruptive**
    - **Crossbills** are seed specialists and are **Irruptive**
    - **Great Gray Owls** are **Irruptive**

Class 15

Unpredictable food shortages (Cont.)

Predatory animals face this challenge of unpredictable food shortages because they **catch** their prey, and they are not guaranteed to catch their food every time.

Storing food when they are able to hunt more is one technique some **predatory** animals use to prepare for when food is short.

Larder is the location of where animals store their food
- **Northern Shrikes** larder is spines they impale the food in
- **Owls** larder is tree branches they put food on

Scatter Hoarding is the action of saving food in many different locations
- **Gray Squirrels scatter hoard** and in the winter, find the locations by memory to dig them back up.
- **Gray Jays** also **scatter hoard** food winter

Red Squirrels create **Middens** which are a number of large storages of cones

Beavers create a **food pile** which is a central cache (one storage of all the food) of branches
- **Drag Trail** are trails where **Beavers** have dragged branches
- **Poplar** branches are what **Beavers** like to eat

Physical Adaptations for Food Storage
- **Chipmunks** have **expandable cheek pouches** that allow the **chipmunk** to store many seeds in its mouth at once
- **Enlarged salivary glands** encoat their food in saliva (Gray Jay)
    - **Gray Jays** have **enlarged salivary glands**
- **Sticky Saliva** to help glue the food onto things (Gray Jay)
    - **Gray Jays** have **sticky saliva.**
- **Nesting Early** allows birds them more time to store food (Gray Jay)

    - **Gray Jays** nest early.
- **Spatial Memory** is the memory of the habitat, revealing the location of their food
    - A large **Hippocampus** provides excellent **spatial memory**
        - **Chickadee's hippocampus** grows before the winter
    - **Gray Jays** have **spatial memory.**

Frozen food (animals) are thawed out by animals sitting on the dead animal before eating it to thaw it out.

Plants Food Challenges

Not all plants make their own food (most do), and there are prerequisites for the ones that do.

Photosynthesis is the process used by **plants** to create food

Heterotroph is a plant that cannot make its own food.

Autotrophic is a plant that can make its own food through **photosynthesis,** and require certain materials for this process to occur.

- **Water**
- **Sunlight**
- **Nutrients**
    - Nitrogen
    - Phosphorus
    - Calcium

Mycorrhizae are **fungal partners** with plants that help provide plants with required nutrients that can be hard to find by the plant directly.

- **Mycorrhizae** also prevent **toxic compounds** from being consumed by the plant.
- **Endomycorrhizae** are **mycorrhizae** found inside the roots
    - **Orchids** have this
- **Ectomycorrhizae** are **mycorrhizae** found on the outside of the plant
    - **Spruces** have this

Bogs are areas where materials for **autotrophic** plants are hard to find

- **Heath** plants thrive in **bogs** and survive with the help of **mycorrhizae**

Alders have **Root Nodules** that convert **nitrogen** for plant consumption

Carnivorous plants eat insects for nutrients

Adhesive (Sticky) Traps are used by **carnivorous** plants to trap insects to eat.

- **Sundews** have sticky hairs on the outside to capture insects and have hairs on the inside that contain **digestive enzymes** to digest the prey
- **Butterworts** also use **adhesive traps**

Pitcher-plants are **carnivorous** and have **pitfall traps**

- They have colorful patterns on the opening to attract insects and have **downward pointing hairs** that direct the animal down to a slippery slope that leads to a pitcher of water from rain. The plant then adds digestive enzymes in the water to eat the prey.

Bladderworts are also **carnivorous** and have **suction traps**

- They have **underwater leaves** that have small nerves on them that cause a chain reaction when an insect touches them; a trap door opens, sucking up the insect, and then enzymes digest the prey.

Shade is a lack of sunlight and this poses as a problem to plants

Shade plants have a **large surface area** of leaves and have more **chlorophyll b** than **chlorophyll a** to bring more sunlight in.

Round-leaved orchid have huge, **thin** and **flat** leaves turned outwards to capture more sunlight

- **Thin** and **flat** leaves offer other advantages as well
  - Less energy spent in building support issues
  - Light reaches photosynthetic cells more quickly
  - Keeps other plants from growing nearby as competition

Hobblebush also have huge leaves with a **large surface area** to capture more sunlight.

Bunchberry plants have a lot of leaves and have a **Clonal Growth,** meaning the plant has a lot of leaves to capture sunlight.

Phototropism is growing away from **shade**

Wild Cucumbers have **thigmotropic tendrils** (wrapping around on touch) and attempt to grow on top of possible competition.

Trilliums bloom before trees have a chance to grow their leaves back from the winter, and are

Spring Ephemerals do not live for very long as they face the issue of frost because they bloom early, and issues dealing with cold temperatures.

Class 16

Mycoheterotrophs are plants that do not require sunlight because they get nutrition from fungus (**mycorrhizal**)

- **Coralroots**
- **Indian Pipe Flower**
  - Gets its carbon products from living plants, thereby it lives like a **parasite** and is also a **mycoheterotroph**

Mixotrophs are plants that make their own food through **photosynthesis** AND get food from **mycorrhizae** (fungal partners)

- **Shade Dwelling Orchids** are **mixotrophs**

Holoparasites are plants that steal food from other plants **mycorrhizae,** that is the only source of their food. They copy a plant's chemicals to attract that plant's **mycorrhizae.**

- **Cancer Root** plant is a **holoparasite**
- **Witch's Broom** is an abnormal growth of leaves in a tree. (http://i66.tinypic.com/2dt6gep.png)
- **Dwarf Mistletoe** is a **holoparasite** and it attaches itself to other trees, causing a **witch's broom** growth on the tree, and begins stealing its food, commonly **conifers tree.**

An excessive amount of sunlight is a problem to plants as well

- **Plants** have leaves with **small surface areas**
- **Buttercups** has **angled** leaves in addition to a small surface area, to combat the sunlight.
- **Dissected Leaves** are leaves that are very chopped up, producing a small surface area.

Animal Reproduction

Asexual vs **Sexual Reproduction**

- **Asexual** reproduction is when an animal creates a carbon copy of itself - the cells are split, and a copy is made. The downside of this is that there is no variation in genes, meaning there is a lack of change so evolution does not occur.
- **Sexual reproduction** offers variety in the genes of the offspring, helping evolution.

Sexual Selection is a subset of **natural selection**

- **Female choice** is a major part of **sexual selection** and a driving force in evolution (stronger male mates produce strong offspring)

Amplexus is a hold that **Male Frogs** do on females, they hug the female and press near the stomach in order to stimulate the **female frog** into laying eggs so that the **male frog** can fertilize them.

External Fertilization is when fertilization (sperm meeting eggs) occurs outside the body.

- **Frogs** use external fertilization
- **Fish** use external fertilization
- Sperm is not guaranteed to meet the egg.

Internal Fertilization is when fertilization occurs inside a body, and is used by most animals. This better guarantees fertilization.

- Does not require male and female to have intercourse

Hermaphroditism doubles an animal's chances of reproducing, typically these animals are slow moving.

- **Sponges**
- **Clams**
- **Slugs/Snails**
- **Worms**

Sponges and **Clams** reproduce using **internal fertilization,** male sponges release their sperm into the water which is picked up by female sponges and used for fertilization.

Springtails do not meet their mates and instead leave **spermatophores** which are sperm-filled packages that males leave for females to pick up.

Intromittent Organs are organs used to insert into another organ in order to deliver sperm

- **Slugs** and **Snails** have called 'love darts' that are used to inject sperm into each other.
- **Spiders** use **palps** that are special mouthparts and are used to insert sperm into the female's genitalia.
- **Snakes** have two **intromittent organs** called **hemipenes** (half penis), this allows them to mate with females from either side (left or right). **(but not at the same time!)**
- **Cloacal Kiss** is when birds mate, they do not have penises, instead they have **cloacas**, which they press together during mating that trigger sex cells to be released.
- **Mammals** have an **intromittent organ** called the **penis,** and is primarily used to deliver sperm.
    - **Penises** also serve to stimulate the female, to result in better ovulation.
        - **Cat** penises have spines on it for stimulation
    - **Penises** are enlarged when needed, this is to protect it from being hurt or to stop it from hindering the animal's movement.
- **Penis Bone** (Baculum) that provide more support to the penis.

Meeting the mate

Barnacles meet by chance, the male's penis begins moving and attempts to find another **barnacle** to mate with. They have a 'wandering' penis and it can be 40x larger than themselves.

Advertising

Auditory Advertisements are used by animals to notify other potential mates that they are prepared to mate.

Non-vocal auditory advertisements

- **Drum** is the sound that **Woodpeckers** create by hammering their beaks in wood
- **Ruffed Grouse** produce **drum** by flapping their wings really quickly to generate the sound.
- **Snipes** make their sounds by vibrating their tail while in the air**,** this action is called **Winnowing**
- **Stridulation** is producing sounds by rubbing body parts together
    - **Crickets** and **Grasshoppers** can advertise by rubbing their body parts together.
- **Cicadas** use their **tymbals** to make loud noises during **really hot days** (they require that heat to move their muscles rapidly), attempting to attract females.

Auditory Advertisements can also be produced vocally

- **Toads**/**Frogs** take in air in small spurs through their nostrils, filling up their vocal sac. Their sound is produced internally and then resonated in the bloated chamber. These are **extensible throat sacs** that act as **resonating chambers.**

Class 17

Auditory Advertisements (cont.)

Males make these **auditory advertisements** to attract females.

Tympanum is an eardrum that helps processing sounds.
- Male animals have larger **tympanums** than females, perhaps to listen competitors better.
- **Male Bullfrogs** have larger **tympanums** than **female Bullfrogs**

Syrinx is a structure in **birds** that allows them to sing two songs at one time. This means they can produce **two different** songs at the same time, resulting in one combined song.

Bird songs are used for **advertisement** to females and **ownership of territory** to other males.
- **Warblers** sing two different songs
  - Sing one for **ownership of territory** and a different one for **mate attraction**
- **Female birds** choose **males** based on their song; they look for males with good songs.

Rut is the **moose mating** period, and usually there is a mist around the area with little frost.
- **Moose Cows** (females) create **auditory advertisements** for **Moose Bulls (males).**
- **Moose Bulls** (males) creates sounds by **thrashing,** this tells other males that they are here and to stay away and tell females that they are interested in mating as well.

Advantages of Sounds (Mate Attraction)
- Sounds carries a long distance, so mates can come without seeing the animal making the sound, as well as there is a greater chance of reaching more mates.

Disadvantages of Sounds (Mate Attraction)
- **Predators** and **parasitoids** can hear you
- **Satellite Males** are males that wait on the borderlines of other male territories, listen for their advertisements, and then steal mates
  - When the female comes in, they pretend to be the male that generated the sound, and attempt to mate with them.

Visual Advertisements

Birds have **bright colors** in order to get attention from **female birds.**
- **Female Mallards** choose **males** with the most **green head.**
- **Female House Finches** choose the most **brightly colored** males.

- **Phalaropes** are one of the few species where **females** are colorful and are selected by the **males.** The females court the males, and once they have mated, the female lays her eggs and leaves, finding a different mate.

Ornaments are badges of maturity or status, shown to impress female mates.

Atlantic Puffins grow grooves on their beak that take **two years** to grow, each.
- **Females** only choose **males** with **two or more grooves.** This is because this proves the male is a good long term survivor.

Antlers are **ornaments** and change size and shape with age
- They reveal age and health of the animal; deformed antlers might indicate clumsiness.
- The spikes on antlers are called **tines,** and the flat part is called **palms,** both change with age.
- **Velvet** is the material that covers the **growing antler** and provides nutrients.
- They are shed every winter and grow back the next year; they are **only** used for **mating.**
- **Sparring** is done by two male animals with antlers to determine which animal is stronger.
    - Even though it is not meant to be fatal, accidental injuries may hinder the animal's ability of finding a female.
- **White tailed deer** have **antlers**
- **Bull (male) Moose** have **antlers**

Dobsonflies (Only Male) has gigantic tusk-like structures that can be used to fight other males.

Ritualized Displays are displays in a species that is common amongst that species
- **Hooded Mergansers** use **Head Displays** and have a **hood** on their head
    - **Males** raise and lower their **hood** to impress **females**
- **Ruffed Grouse** use **Neck Ruff** and **Tail** displays
    - Their neck feathers (afro like) show around the neck during mating season. They use this **neck ruff** and **tails** to attract **females**

<u>Class 18</u>

Aerial Displays

Swarms of male **Midges** form and wait for **females** to fly in, upon which they dance, and the **female** chooses the best **dancer.**

Female Ebony Jewelwing (Damselflies) have **white spots** on the end of their wings and flap their wings **rapidly** to notify a nearby male of **acceptance** or open up their wings **flat** to notify a nearby male of **rejection**

Male Ebony Jewelwing sperm is produced in a holding chamber near their head. They have a pinsir used to hold the female during courtship and used to put their sperm in the female, as well as removing any existing male's sperm.

Fireflies use **aerial light display** and flash their light in a specific pattern to find potential females.

Synchronized Displays are displays where **both** the male and female participate

- **Swans** perform **Mutual Displays,** doing series of actions together **at the same time**
- **Sandhill Cranes** perform **Ritualized Dances,** taking turns bowing and jumping.

Communal Display Grounds are where males gather to perform a common display action together to get attention from females

- **Leks** are where **male birds** gather to perform to impress females
    - **Male Sharp-tailed Grouse** dance at **leks**
- **Male Wild Turkeys** gather together and dance for the female

Olfactory (Smell) Advertisements are **Sex Pheromones** (are chemical advertisements) and are a safer form of advertisement, as predators usually do not track these pheromones.

Cows (female moose) urinate to spread their **sex pheromones** for **Bulls** (male moose) to hear and smell.

- **Bulls** will lick the air to grab pheromones and will try to analyze them.

Rut Pits (Wallow Pits) are pits that **Bulls** (male moose) make by their hooves that they urinate on to release their **sex pheromones,** they roll in them to pick up those pheromones.

Female Snakes leave **Pheromone Trails** for males to track, this leads to males **swarming** where multiple male snakes gather in attempts to court the female.

Female Insects produce **sex pheromones** that **males** track using their **antennae**, leading them to the female.

- **Silk Moths** advertize with **Pheromones** and purely exist for sexual reproduction, as they have no mouth after they come out of pupae stage, leading to death by starvation.

Male Snowshoe Hares urinate on the female to stimulate her, this contains **pheromones.**

Porcupines urinate in the same way as the hares.

Gift Giving Courtship is when a male impresses females by giving them something, showing that they will be good providers for any young.

Cedar Waxwings give each other food as **courtship gifts**

Male Terns also give **females** other food as **courtship gifs**

Males give females food as **courtship gifts** to prevent being eaten by the female after sex.

- **Spiders** and **Scorpion/Dance Flies** do this

Male Marsh-wrens offer **dummy nests** to females, and create a large number to attract a lot of females, as they are polygamists.

Male Bass/Bluegill Sunfish are composed of **three** types

- Big colorful **Males** that make nests and attracts females normally and honestly
- **Satellite Males** that aim to steal females the **big male** attracts, this type of male is composed of two types
    - **Juvenile Males** wait for females to approach and instantly release their sperm on them, they don't face risk of the **big male** as they aren't viewed as competition
    - **Males** that pretend to be a female, entering the **big male's** nest and releasing their sperm on females that it attracts, they face risk of being killed from **big males.**

Wheel is a sex position assumed by **Dragonflies/**Odonates which is where both the female and male form a circle. (http://i66.tinypic.com/246714k.png)

Males Ensuring Paternity

Contact Guarding is staying close to the female after mating, protecting her from other males

- **Bull Moose** guard **females** after sex
- **Male Odonates** use **Claspers** latch onto the female.

Walking Sticks use their **claspers (handcuffs)** to keep the pair coupled for one to several days, preventing other **males** from mating, they experience **Long Copulations.**

Anti-aphrodisiacs are added to the female after mating that turn other males off, lowering the chances of males coming to court the female.

- **Male Mosquitoes** add them

- **Male Garter Snakes** add them

Copulatory Plugs are used to seal female openings with a male's **sperm**, preventing other sperm from making it through.

- They are **NOT** guarantees. Males can have methods where they can sometimes remove these plugs.
- **Beetles** produce **headless sperm** that do not fertilize but **plug** the females opening so that no other **male's** sperm gets through
- **Featherwing Beetles** use **Giant Sperm** which is a huge sperm that acts as a plug
- **Male Mosquitos'** sperm contains cement-like material that hardens, preventing male sperm from making it.
- **Honey Bees' genitals explode** during sex and they die. This acts as a plug on the female, a huge plug.

Class 19

Plant Reproduction

Flowers exist only to reproduce and are **hermaphroditic.**

Flower Sex Organs are composed of the following

- **Stamens** produce sperm and are the male **sex organ**
- **Pistils** produce eggs and are the female **sex organ,** they are composed of the following
  - **Stigma** is the part that receives the sperm from the **male**
  - **Ovary** is the part that holds the eggs.
  - **Style** is the long neck of the **pistil**
- http://i64.tinypic.com/ac4i9z.png

Anther Cone is a cone of **Stamens** fused together like the head of a rocketship almost.

Pollen-grains produce sperm and are transported to female plants for fertilization

Pollination is when the sperm meets the egg and fertilization occurs.

Double Fertilization is unique to plants and is the fact that two eggs are fertilized by two sperms. Only one becomes an **embryo**; the other egg becomes food for the **embryo**.

Transporting Pollen-grains

Pollinators are animals that transport **pollen grains** from one plant to another, usually in exchange for food.

- **Hummingbirds, Bees, Butterflies** and **Beetles** are examples of **pollinators**

Anemophily is wind pollination where the wind transports **pollen grains** to other plants.

- This requires their **pollen grains** to be small and lightweight.
- Plants produce a large amount of pollen grains as delivery is not guaranteed
- **Sedges** produce pollen designed for the wind, are wind-pollinated
- **Grass** is wind-pollinated
- **Ragweed** is wind-pollinated
- **Conifer** is wind-pollinated

Hydrophily is water pollination, but is used by very few plants.

Entomophily is pollination by **Insects,** the plant usually offers food to the insects, such as **nectar** or the pollen itself.

Nectar is usually sugar water.

Long Spurs store **nectar** and require long mouthparts to access their **nectar**

- **Cardinal Flowers** are red and have **long spurs** and attract **hummingbirds**
- **Hummingbirds** can reach **Long Spurs**
- **Long-tongued Bees** (including **Bumble Bees**) can reach **Long Spurs**
- **Moths** can reach **Long Spurs**

Buttercup Plant stores **nectar** in sleeves at the base of petals called **Buttercup Nectaries**

Milkweeds hold **nectar** in shallow cups

Bees have a **Pollen Basket** on their legs which carries the **pollen** they collect from plants and have special legs to grab pollen from the plant.

Attraction Advertisements to Pollinators

Shape and **Colour** are **Long Range Visual Attractants**

Insects see colours differently than humans, and specific combinations attract specific insects.

- **Red** is seen by **very few** insects, but is seen well by **Hummingbirds.**
- Green appears as gray.
- Yellow appears as red.

Scents attract insects to the plant and are **Close Range Attractants**

- **Evening Primrose** releases scents only at dusk because it is attracting **moths** as **pollinators** that appear when the sun goes down

Brood Site Deception is when a flower release scents that attract **insects**, making them think the plant is a place to lay eggs

- **Wild Ginger** attracts **Fungus Gnats,** smells like decaying fungus**.**
- **Red Trilliums** attracts **Carrion Flies,** smell like rotting flesh.

Nectar Guides are patterns on flowers that guide insect to where the **nectar** is stored

- **Insects** see patterns that seem invisible to humans, extremely visible to them, and hence a lot of nectar guides are hidden to humans, only visible to insects

Class 20

Cross-pollination (outbreeding) is better than **self-pollination** (inbreeding) because it creates a greater **genetic diversity.**

Avoiding Self-pollination

Self-incompatibility is the inability of plants to self-pollinate; this occurs due to chemicals that fertilize the egg realizing the pollen and not coming into agreement, preventing fertilization.

Spatial Separation is keeping male/females apart from each other to prevent self-pollination and there are two techniques of achieving it

- Sexes can be placed on different parts of the tree or plant.
  - **Females** are generally at the top, and **males** are at the bottom, this is due to the wind carrying **pollen** and is better for it to be blown up to the **females.**
- Sexes can appear on different plants, making each plant have one gender
  - **White Campion** are either only **male** or **female**

Spatial Placement is having the sexual organs placed differently.

- **Bottle** (Closed) **Gentian** have their sticky **stigma** near the top to capture pollen from insects landing, and have their **stamens** underneath to prevent any self-pollen being consumed when the insect is leaving from the bottom.

Dichogamy (temporal separation) is a plant being a different sex depending on the time, preventing the plant from being both sexes at the same time.

- **Jewelweed flowers** start off as males until eventually the **stamen** falls off and reveals the flower's **stigma,** leaving them females.
- **Spiral Flowers** start off closed, the **lower flowers** open first and are male with **pollen,** and change into **females** after that **pollen** is removed
    - **Pollinators** start at the lower flowers and work their way up, once the lower flowers change to female, the pollinators are attracted to them and pollinate them, and then go back to the males, leaving with **pollen**.

Pink Lady's-slippers pretend to have **nectar** but actually do not, they are closed and require strong **bees** to come around and open them, are bee-pollinated

- Hairs start getting thicker near the flower's top, serving as **guidance patterns** towards the top
- **Staminodes** are a mixture of **stamens** and **pistils** that are near the exit at the top in the plants and capture **pollen** off the **bee**

Pseudo-pollen are hairs that are fake-pollen, they attracts **pollinators** looking for real pollen and place **pollen** on a **pollinator** that comes in believing it is real pollen**.**

Pseudo-nectaries are hairs that are fake-nectar that glisten to look like **nectar.**

- **Grass-of-Parnassus** attracts pollinators using pseudo nectaries

Bee and **Fly Orchids** look and smell like female **bees** and **flies** respectively, attracting the male counter-parts, attaching **pollen** onto them once they attempt to mate with it.

Helleborines release fake **wound hormones** that attract **wasps**. It does provide nectar to the insects. It is the **only plant in the world** that does this.

Heterostyly is a plant having multiple forms based on length of their **style**

- **Pickerelweed Flowers** have three forms of flowers.

- **Purple Loosestrifes** have three forms, **pollen** from one form cannot pollinate the same form; it must pollinate a different form**.**
  - A **short** style form
  - A **medium** style form
  - A **long** style form
  - http://i68.tinypic.com/id61ig.png

Queen Anne's Lace are white flowers, but have a tiny purple flower inside it; no one knows why. A theory is that it is possible a decoy for insects to land on.

Milkweeds have **slits** to capture an insect's leg walking on it so that it can clamp on a **saddlebag** of pollen onto the captured leg. **Slits** will clamp off existing **pollen saddlebags.**

White Water-Lilies are initially female and have openings that attract insects, they close near nighttime and traps insects currently inside it. It becomes a male by morning and grows stamens that insects have to go through to exit the opening, leaving with **pollen** on them.

Grass Pinks have **pseudo-pollen** on a petal that collapses on contact, forcing an insect to fall on the sexual organs of the plant. Insect's back will be inspected for **pollen** by female parts, and it will leave covered in **pollen**. (Slam Dunk Method)

Laurels have **bashing stamens** that are bent stamens that hit the **pollinator** if it steps on one, covering it with **pollen.**

Bunchberry (*pop flowers)* are closed initially and have spikes that pop the flower open once stepped on, putting **pollen** over the triggerer. Its **stamens** are the **fastest** moving floral parts in the world.

Twayblades have petals that start off as **males**, and upon being stepped on, release pollen onto the triggerer. Those petals change to **females** that pull off pollen once triggered.

Cross-pollination is the general rule, but in some cases, **self-pollination** is necessary.

- **Dandylions** primarily **self-pollinate** because they typically grow in habitats that are dying.
- **Cleistogamous Flowers** are an insurance policy of reproduction and are near the warm soil, they **self-pollinate** incase the plants above are not able to due to usually cold conditions
  - **Spring Ephemerals** have these

Class 21

Seed Dispersal is **plants** getting off their newborn seeds to a good start in life.

Advantages of seed dispersal

- Avoiding crowding and competition with the mother plant
- Prevents spreading of diseases or parasites
- Prevents inbreeding
- Saves some of the offspring from being eaten (since they will be in different areas, not one predator will get to all of them)

Plants protect their seeds until they are mature.

- **Physical protection**

        - **Cones** have physical protection (the cone itself)
        - **Hard Seed Coats (Armor)**
            - **Acorns** have hard seed coats to protect the seed.
- **Chemical protection**
    - **Terpenoids** are used to protect the seeds
        - Berries taste bitter when they are not ready to be consumed
        - **Aposematic Colouration** (warns predators, don't eat me I'm not ready)
        - **Resin,** a **terpenoid,** is used for chemical protection
            - **Cones** have **resin**
    - **Milkweed** seeds are protected by the **pod** that holds the seeds
        - The pods are full of **Cardiac Glycosides (Terpenoids)**

Plants have multiple ways of sending off their **seeds**, so that the **seeds** can grow into plants.

Anemochory (Wind Dispersal) is dispersing seeds by the wind and is used by many plants that grow in open sunny areas.

- **Dandelions** use **anemochory** for **seed dispersal**
- **Anemochory** has a problem, which is that the seeds might miss the target habitat, seeds may land on water and other places it shouldn't, they solve this by producing a **large quantity** of **seeds**
    - **Fireweed** produces **70k-100k** seeds.

Zoochory is dispersing seeds through animals

- Some plants latch onto animals bodies and travel to target habitats that way
    - **Hooks** and **barbs** of seeds get caught on hairs or feathers of animals, they hitch-hike
        - **Stick-tight plant** does this
    - **Velcro** is used by Burs to stick onto animals
    - **Queen Anne's Lace** has an **umbel** which contains its parts that will attach seeds to animals, and it closes during **wet** days and opens up during **dry** days.
- Some plants seeds travel **inside** the animal, those animals are called **seed dispersers**
    - **Seed Dispersers** are animals that eat fruit and then poop out the seeds (thereby allowing seeds to grow into new berries and so on)
        - **Blackbears** eat **berries** and are **seed dispersers**
        - **Waxwings** eat **berries** and are **seed dispersers**
        - Not all animals are seed dispersers, there are also seed predators that **eat** the seeds, and this is one of the risks of traveling inside the animal.

There are environments where **anemochory** is not possible, so plants have other methods

Some plants entice animals to carry their seeds for them by providing them something in return

- **Spring Ephemerals** pay **ants** (mostly carpenter ants) for dispersing seeds.
  - The **ants** are enticed by **elaiosomes,** which are special protein packages on the seeds, that **ants** cannot resist.
- **Violet** also have **elaiosomes** on their seeds as well and use ants
  - They use **ballistic ejection** which is a plant throwing out its seeds somehow, to get the seeds on the ground for **ants** to then take over.
- Some animals that scatter hoard seeds end up helping the seeds **if** they don't eat them during the winter (usually if the animal that hoarded is killed or forgets the location)

Some animals use **raindrops** to **seed dispersal**

- **Splashcups** are cups that contain seeds and use **raindrops** to splash their seeds out for **seed dispersal**
  - **Miterworts** have **splash cups** to disperse, when a **raindrop** hits that cup, it pops out the seeds from the cup.
- **Foamflowers** have **springboards**, which act like a diving board; **raindrops** hit the end and then the **seeds** pop out

Some plants have adaptations for **wind dispersal**

- **Maple samaras (keys)** seeds have little wings on them so that the seed do not land directly underneath the tree
- **Basswood seeds** have **sails** that help them fly when the seed is dropped.
- **Perched Birch Trees** are **Yellow Birch** trees that had their seeds grow directly underneath them due to a lack of adaptation
- **Indian Pipe** flowers time the maturing of their seeds, they bloom late in the summer when wind is available to blow away its seeds.

Some plants grow near the shoreline, so their seeds end up landing on water, they have adaptations for that

- **Hydrochory** is water dispersal, and **seeds** have **flotation devices** helping them float on the water so that wind or a current takes them further away from the original plant**,** then they sink to become a flower underwater
- **Jewelweed** grows in wet places, and use **Ballistic Ejection,** when the plant is touched, its **seeds** are thrown several meters from the plant.

Boom or bust strategy is when plants control their seed population depending on the condition; produce less if conditions are poor, produce more if conditions are good.

Parental Care is **animals** getting off their newborn children off to a good start in life.

There are certain animals that do not care for the young after fertilization

- American Toads do not care for the young after fertilization

There are animals where females choose the right habitat for their eggs before laying their eggs

- **Dragonflies** choose the right habitat before laying their eggs
- **Ephemeral Ponds** are temporary ponds caused by snow drying up and resulting in large amounts of temporary water
    - **Freeze-tolerant frogs** use this, as since they are **freeze-tolerant,** they un-freeze with the snow, so they get to lay their eggs in these **ephemeral ponds** before any fish are there, so their young is protected. This COULD be a reason why these frogs are freeze-tolerant in the first place.
- **Small Snakes** choose **under rotting logs** as place for laying their eggs, as this provides a warm and humid environment for the eggs.
- **Monarch Butterflies** lay their eggs on young **milkweeds** so that the **caterpillars** are able to eat the **milkweed** when it hatches. (Idea is laying the egg on the young's food source)

There are animals where the **mother** guards the babies after they hatch

- **Parental Care** in **turtles** stop after laying their eggs in the ground, the only **parental care** they put in is digging a hole and laying them there so they have a higher chance to survive.
    - The soil **temperature** determines the **sex** of the turtle

Class 22

Gestation period is the period of pregnancy for mammals.

Walking Stick eggs are laid on the ground, but are transported underground by **ants** as they have edible **capitulum** that ants like**.**

Ovoviviparity is holding eggs internally until they hatch
- **Northern Water** and **Garter Snakes** do this

There are animals that lay and then guard their eggs
- **Five-lined skinks** (females) lay and guards their eggs inside rocks, thereby protecting them.
- **Red-backed Salamanders** guard their eggs, they lay their eggs inside **rotting** logs
- **Wolf Spiders** guard their eggs by carrying them in an **egg sac** that they carry on their **spinnerets** (back). Eventually the baby spiders hatch and hang around the mom's body.
- **Nursery Web Spiders** guard their eggs by carrying them in an **egg sac** that they carry in their jaws.
    - They build a **nursery web** and guard their **egg sac,** this web also protects their young.

There are animals where the **male** guards their eggs

- **Bass** (fish) do
- **Giant Water Bugs** carry the eggs on their back

Precocial is when an animal is born in a relatively mature state.

- **Precocial** baby birds leave the nest after hatching, they are self-sufficient**,** and they stay in the egg two times as longer as **altricial** baby birds.
  - Their nests **are not very developed,** and are very small.
  - **Precocial** baby birds are called **chicks**

Altricial is when an animal is born in a helpless state.

- **Altricial** baby birds live in the the nest and are not ready after hatching for the outside world. They do not stay in the egg for a long time and that is why they live in the nest.
  - Their nests are **heavily developed.**
  - **Altricial** baby birds are called **nestlings**

Moose guard their young, both when it is pregnant for eight months and up to a year after the young is born.

- Their young are **precocial**, but the mom still protects its young for a year
- The total **parental investment** is 20 months.

In 95% of **mammals, females** are the ones providing **all** of the **parental care,** but there are exceptions.

Biparental care is when both the mom and dad provide care to the young together

- **Foxes** and **Wolves** have **Biparental Care** (which is both partners providing care).
- More than 90% of **all birds** provide **biparental care.**

In **Social Animals,** the entire group will help raising the young.

- **Wolves** are social animals and in their **packs,** one female will have children and the rest of the **pack** will provide food and help raise the pups.
- **Rendezvous Sites** are places where pups are placed and then adults bring food to them.

Black Bear cubs are born highly **altricial,** so the female does not invest a lot internally. The female then protects the cubs for two years.

Opossums have **extremely altricial** young, their pregnancy period is merely **13 days**

- The young travel into the **pouch** of the mother immediately to get nutrition
- **Opossums** have forked penises and forked vaginas (very important for final)

Delayed Implantation is when the sperm goes to the uterus a certain period **after the mating occurs**

- **Bears** have a short **gestation** period of **2 months,** this is made possible through **delayed implantation,** this is so that the female can get ready for the winter
- **Fishers** have **delayed implantation** and this allows the female to mate conveniently**.**

Some animals store the sperm and the sperm meets with the egg at a later time

- **Bats** have a short **gestation** period of 40 days, and this occurs because bats store their sperm in a separate compartment, and during their **dormancy**, the sperm meets egg.
- **Social** insects such as Bumblebees also store sperm.
    - **Social** insects also display **group care,** where some workers help take care of the young.
        - **Wasps**
        - **Ants**

Class 23

Incubation (sitting on egg to keep it a warm constant temp.) is a **parental investment** by **birds,** by sitting on the eggs.

Birds have **brood patches** near their stomach which is loose bits of skin that has no feather, that keep the eggs warm, and this is what is place on the egg when it is being **incubated.**

- In **Phalaropes, males** develop **brood patches** and **incubate.**
- In most other species, the **females** develop **brood patches** and **incubate.**
    - **Ducks** and **Grouse females** develop **brood patches** and so **incubate,** since the males leave after mating
    - **Hummingbirds** develop **brood patches** and so **incubate.**
    - **Songbirds** develop **brood patches** and so **incubate.**
    - **House Finch** develop **brood patches** and so **incubate.**
- In some species, both the **male** and **female** develop **brood patches** and **incubate**
    - **Killdeer,** both the **male** and **female** develop **brood patches** and **incubate**
        - **Males** do the night shift of **incubation**, **females** do the day shift.
    - **Northern Flickers (Woodpecker),** both develop **brood patches** and **incubate**
        - **Males** do the night shift, females do the day shift.

Clutch is a group of eggs of a single bird.

Synchronous hatching is when all the eggs of a bird hatch more or less at the **same time.**

Asynchronous hatching is when the eggs of a bird hatch at **different times.**

- This lessens the feeding stress on the parents, as they are predatory birds, if they were all the same age, they would all need the same amount of food, which may be overwhelming.

- Increases chances of survival (if one leaves the nest, and the nest is destroyed, that one survives)
- Ensures survival of some young in times of food stress since young need less food
- **Siblicide** is when the older siblings eat the younger siblings, this is usually due to food stress.
- **Owls** and **Hawks** hatch **asynchronously.**

Nest Sanitation is apart of **parental care.**

- **Fecal Sacs** are sacs that surround **nestling** poop, making it easier for parents to remove the poop from the nest.
- **Hawks** add green conifer sprigs to nests as those conifer sprigs contain **tannins** that prevent **nest parasites**

Feeding is apart of **parental care.**

- Young chicks have **bright yellow** spots in their mouths, to tell the parent where to put the food.

Nest Defence is apart of **parental care.**

- **Aggressive Responses** is one way of defence, physically attacking the threat.
  - **Gulls** and **Terns** begin puking and pooping on threats in order to defend their nest.
- **Paternity Dependent** defence is when the **male** defends areas more where the chicks are more of the **males**
  - **Red-winged Blackbirds (males)** have multiple female mates and know which areas have more chicks that belong to them, and they defend these areas more.
- **Distraction Displays** are when certain birds lead the predators away from the nest.
  - **Rodent Run** is when small ground birds run in multiple directions and circles to lead predators away from the nest.

Class 24 (Last Class)

Nest Defence (cont.)

- **Distraction Displays**
  - **Feigned Injury** is the act of pretending to have an injury to lure predators, since the predators will think the animal is easy prey.
    - **Ducks** do this, and is called a **Broken Wing** act
    - **Killdeer** do this as well, and it is called a **Simulated Wound,** they have red patterns on them that they pretend is blood.

Creches (Brood Amalgamation) is when one female drops off her young to another female, this provides safety in numbers and a higher survival chance of a female's young to survive a predator attack.

- **Ducks** do this.

Intraspecific is when **facultative brood parasites** occur within the parasite's own species.
Interspecific is when **facultative brood parasites** occur within different species.

Facultative Brood Parasites are animals that rely on other animals to raise their young.

- **Mergansers (ducks)** do **Egg Dumping** is when a **duck** dumps its eggs in another female **duck's** nest.
- **North American Cuckoos** are **facultative brood parasites** and are both **intraspecific** and **interspecific.**

Brood reduction is when the born babies of an animal is reduced (meaningless animals survive than the amount that was born)

- **Opossums** can have as many as 20-50 babies, but only have **13 nipples,** meaning the first 13 that get to the nipple are the **only** babies that survive.
- **Eagles** have their oldest eaglet kill the youngest eaglet, the adults do not care as eagles only need one child. The younger child is an insurance policy incase the older one dies. This is a form of **siblicide.**

Infanticide is when an adult animal kills a baby animal.

- **Female Muskrats** kill their neighbour's young.
- **Tree Swallows** (Birds) males kill a female's children when they come to mate with a female. The female then becomes ready to mate again to have that new male's children.

Bruce Effect is when a **Female Meadow Voles** that is pregnant will abort its own children if a new male comes in as the new male will kill the newborn meadow voles.

Obligate Brood Parasites are animals that get other animals to completely raise their young, completely from incubation to feeding.

Brown-headed Cowbirds are **obligate brood parasites** and never build nests.

- Adaptations
  - They lay their eggs **fast (20-40 seconds)**
  - Their eggs have **thicker egg shells** so that foster parents cannot open it.
  - Their eggs hatch **faster (10 days)** so that the babies get most of the food from the foster parent
  - They replace eggs from the foster parent's nest so that the number of eggs is the same
  - **Young cowbirds** outcompetes **nest mates** indirectly.
- Reasons for success
  - They create up to 40 eggs per season
  - They lay their eggs up to 220 different species
- Finding host nests
  - **Sit on a high perch,** watching for nest-building occurring
  - **Walk on ground,** watching for nest-building occurring
  - **Drive bird off nest** by flying into shrubs and leaves and noisily flapping wings to scare the bird

Certain birds can figure out **obligate parasites** and have adaptations to rid of them.

- Birds can **abandon** the nest and take off to create a new nest
- **Yellow-warblers** can create a new nest on top of the defected one
- **Grasp Ejectors** are large birds that grab the egg that is not theirs
- **Puncture Ejectors** are small birds that break the egg to get a grip and then throw them out.

Mafia Theory is a theory where a bird raises another bird's egg in fear that if it does not, the other bird will come back and smash the other eggs in the nest.

- **Cuckoos** have been known to do this.