

Midterm Notes

Natural History: An observational science that involves looking at all living things. Natural history knowledge is essential for assessments of ecosystems or habitats. It is also one of the most enjoyable pursuits in the world.

Naturalist: One who studies **Natural History**.

Animals: A Kingdom that includes Birds, Reptiles, Amphibians, Fish, Mammals, Insects, Spiders, Clams, and lots of other organisms.

Natural Selection: the driving force behind evolution. It consists of all the selective pressures placed on plants and animals by the environment (such as wind, cold or drought)-abiotic or by animals (such as predators or even members of the same species)-biotic. Those poorly adapted do not survive to pass on their genes and those that are better adapted tend to survive and pass on their genes allowing the adaptation to persist into the future and possibly become more refined. Natural Selection was first recognized by **Charles Darwin**.

Adaptation: any feature that offers a plant or animal an advantage in solving any life problem that give it a chance of surviving and reproducing. An adaptation is not an act of intelligence or a planned solution but a physical, physiological, or behavioural trait that has evolved because of the selective pressures of natural selection. No adaptation is perfect and often an adaptation has drawbacks associated with it that require another adaptation to resolve. This makes Natural History interesting because never is there only one solution to any problem. Instead, many solutions have arisen to solve every challenge.

Defences of Animals :

A) Physical

CAMOUFLAGE: colours and patterns that allow animals to blend into the background.

Crypsis: the art of concealment or remaining hidden - camouflage combined with motionless behaviour

Types of Camouflage

1. **Background Matching:** Having the same general patterns and colours as the immediate environment. *Examples:* For sun-dappled forest habitats, blotches and earth-toned colours help animals hide. *Examples:* ground nesting birds such as female grouse (also female ducks), White-tailed Deer fawns.

Gray Tree Frog** also changes its colour (the only other animal we have that changes colour is a Snowshoe Hare but they do that seasonally, not every time they are placed on a different background, as Gray Tree Frogs do.)

Different habitats require different patterns for camouflage

Marshes and grasslands are dominated by vertical lines. Many animals sport stripes and streaks in these habitats.

Examples: In grassland habitats - sparrows such as Savannah Sparrow
For marshes(cattail) - American Bittern

2. **Disruptive Patterns:** Patterns that break up the general form of an animal making it hard to see.

Examples: Eyelines and eyestripes on songbirds (especially important when sitting on nests)

- Breast bands on **Killdeer** - **Horned Larks**
- Necklace on Common **Loon's** neck
- (Stripes and lines on **Eastern Chipmunk's** back and face)
- **Leopard frogs** – hind legs fold up against the body. The markings on the body line up with lower and upper parts of leg to create continuous pattern.

3. **Bicoloration:** having a two-toned body, usually dark above and light below, often seen on animals that live near the surface of ponds. Allows for background matching from two directions.

Examples: **Water Boatmen, Backswimmers/Whirligigs** (note: white upper parts and dark bottom – they swim upside down!)

4. **Countershading/ The self-shadow concealment principle:** Having a dark upper surface that shades a pale lower surface that when viewed from the side. This makes an animal appear “flat” and not three-dimensional. NOTE: This is NOT background matching.

Examples: **White-tailed Deer, sandpipers** and many birds including some **hawks**

5. **Masquerade (Background Mimicry):** Having the same physical appearance as part of the environment.

Examples are twig mimics (**Walking Sticks, Inchworm caterpillars**), thorn mimics (**Treehoppers**), bark mimics (**Gray Tree Frog**- fold their front legs under their chest, **Eastern Screech-Owl**), dead leaf mimics (**Anglewing butterflies, certain moths**), live leaf mimics (**Luna Moths**).

6. **Masquerade (looking like Non-background Objects, usually inedible):** Having shapes and colours or patterns that resemble something that is not part of the general background and is inedible.

Spit or froth - *Example:* **Spittlebugs** **Scarlet lily beetles** – larvae

Bird poop - *Examples:* **Bird-dropping Moths, Viceroy Butterfly caterpillars**

When camouflage and cryptic behaviour fails, some animals have a second defence or “*Plan B*”:

Startle Patterns: Bright colours and patterns that when exposed startle the predator giving time for the animal to escape.

Examples: Bright yellow on inside of legs of **Gray Tree Frog**

- Bright hind wings of **Band-winged Grasshoppers**
- Bright hind wings of **Underwing Moths**
- Eye-spots on **Sphinx Moth** hind wings
- Huge eye-spots on **Io Moth and Polyphemus Moth** hind wings
- **Red-bellied snake** – bright orange belly
- **Ring-necked snake** – brilliant yellow

Distraction Patterns: Patterns that serve to distract or deflect a predator’s attention to a non-vital body part. These are often but not always Startle Patterns also.

Deflection Patterns: another name for Distraction Patterns that also serve this function.

Some small butterflies have eye-spots and fake antennae on hind wings that serve as Distraction or Deflection Patterns

Examples: Tailed Blue butterflies, also Swallowtail butterflies; Five-lined Skink blue tail serves to Distract and Deflect Attack (disconnects because of a special zone of cells that weaken its connection.. scurries off and eventually grows a new tail).

Permanent eyespots (never hidden) can be used to fool a predator into thinking the animal is bigger than it really is.

Example: Eyed Elater (beetle), Tiger Swallowtail caterpillar

Startle sound :

- **Grouse:** Wings
- **Beaver:** Tail

Disguise through Behaviour: some animals add bits of environment to body to disguise:

Masquerade artists- Examples: Leaf Rollers, Caddisfly larvae, Sumac Gall Aphids

PHYSICAL DEFENCE can involve hard physical structures that are part of the animal's body:

Hard exoskeleton - **Examples:** many **beetles, millipedes** (made of chitin, pull unprotected parts in)

Shells formed from internal skeleton -**Examples:** Turtles -**Blanding's Turtle** can partially close its shell – hinge on anterior part of the plastron) **Box turtles** – completely close armour.

Snapping turtles – can't withdraw in shell, so they protect themselves.

Hard shells formed from Calcium- **Examples:** **Snails, Clams** (withdraw into shell).

ANIMAL PHYSICAL DEFENCES INCLUDE:

A) Silk webs for Protection: Eastern tent Caterpillar, Fall Webworm

B) Long body hairs: Many Caterpillars- **Gypsy Moth, Woolly Bear**

C) Body Hair (Guard Hairs) Modified into Quills – **Porcupine** – gives visual warnings first : raised tail, chattering of teeth, warning odour from skin above tails base.

ANIMAL CHEMICAL DEFENCES

Poison Spines: Hairs that are branched and tipped with toxins

Example: IO Moth Caterpillar usually Aposematic coloration = Bright warning colouration is involved.

Toxins can have bad taste, make the eater ill, burn etc.

CHEMICAL DEFENCES are found or released by a variety of body parts:

A) SKIN: **Red Eft** (Salamander) (Samandarin); **American Toad** (Bufotalin)

- B) **Mouths** of Grasshoppers and Sawflay Larvae
- C) **LEGS** of Blister Beetles – (Terpenoid Cantharidin)
- D) **INJECTED** by **STINGERS**: Wasps, Bees.
- E) Also on **OSMETARIA** of Swallowtail Butterflies – red horned tips

Some Chemical defences are **SEQUESTERED** = Acquired in Diet, Then stored in the body.

A) Sequestered from plants : Monarch Butterfly Caterpillar eats Milkweed leaves containing **Cardiac Glycosides** (Which are Terpenoids) and Stored in body.

B) Sequestered from Animals:

Fireflies - **Photuris** females eat males of **Photinus** species to sequester **Steroidal toxins**.

Other chemicals are manufactured by the animal : Ladybugs make **Alkaloids**

Some Chemical weapons are released through the anus.

Bombardier Beetle: sprays cloud of hot quinone gas (That is produced when Hydrogen Peroxide is mixed with Hydroquinones and enzymes)

Striped Skunk: sprays **Sulphur alcohol**

Black and white = **Aposematic colouration for warning at night**- Behavioural warnings first to conserve the chemical defence.

Animals equipped with chemical defences often have Aposematic colouration.

Mullerain Mimicry: When a group of animals all look alike and all have a nasty defence such as a bad taste, a sting, poison spines, etc.

- All the look-alikes share a true defence so their aposematic colouration is an honest advertisement.

Examples: Many species of wasps and bees look alike (and they all sting)

Batesian Mimicry: When a harmful model has some unpleasant feature (such as a bad taste or a sting) and there is a harmless mimic that looks like it.

NOTE: The mimic is usually less common than the model .

Examples: (with the model first): **Monarch Butterflies and Viceroy; Wasps and hover flies**

Flocking: Animals travel in groups for safety (**Example**: Birds in Flocks)

- 1) More eyes to watch for danger
- 2) Better odds of not being eaten

Bluffing – Exaggerate size (**Example**: American Toad, Hog-nosed Snake – inflate body with air)

Swallowtail Caterpillars have Osmetaria that look like a snake's tongue (mimicry)

Long-eared and Great horned owls – fluff up feathers.

Playing Dead = **Thanatosis** – Hog-nosed Snakes, Blister Beetle, Opossum

PRE-EMPTIVE AGGRESSIVE ACTION

Mobbing(Pre-emptive defence) : When a group of Birds vocally and physically harasses a predator (Until it leaves their area).

Examples: **Crows** mob **Great horned Owls**; Small birds mob small owls.

Yellowjacket wasps release attack pheromones that send other wasps to attack intruder.

Pishing elicits a mobbing reaction in small birds.

Bodyguards: Some animals enlist the help of more powerful animals.

Examples: **Carpenter Ants** defend **Aphids** and other types of **Sucking bugs** (such as **Treehoppers**). Paid for their services with food in the form of honeydew.

Vigilance =Being on the alert for danger .

Detection of danger involved Vigilance, which often involves scanning the environment for signs of danger.

ANIMALS SCAN FOR:

1) **Vibrations:** can be sensed by some animals

Snakes – have no ears; They sense vibrations in the ground.

2) **Scents:** using their **Noses:** Olfactory sense (**SMELL**) is important

Large snout has a large nasal chamber with many folds to increase its surface area = more olfactory receptors, better detections of odours (Moose, Deer, Etc).

Vomeronasal organ = Jacobson's: Special pocket in roof of mouth that has dense concentration of smell receptors.

Snakes also have this organ. **Snakes** have forked tongues to pinpoint the source of the odour.

Fish have a sensory system called lateral lines, which are pressure sensitive receptors placed in rows along their sides.

3) **Sounds: Auditory Sense** = Hearing is important to many animals. Mammals (**Moose, Deer, Hares**) Have large external ears = Large and Mobile Pinnae to capture sound like parabolic dishes.

Some insects have special ears. (These are actually Membranes that are sensitive to sound.)

Moth Ears: Tiger Moths, Hooktip Moths have membranes on Abdomen for **hearing**

Bats. When **Moths** hear a **Bat** they can take Evasive Action.

Mantids also have ears.

Green lacewings have them on their wings. **Field Crickets** are on front leg. **Praying Mantids** have only one and its between legs.

4) **Movement: Visual Scanners = Eyes** – Eyes located in the middle of the sides of face for better coverage, greater collective fields of view - **Rabbit, Dove** = See 360 Degrees . Frontally placed eyes provide a visual coverage of 100 d. per eye for combined view of 180 d. – blindspot.

Eyes are not always central on side of face – **American Bittern-placed** near their beak, **American Woodcock, Wilsons snipe** – near back of the head – other constraints are involved.

Flocking - Increases Vigilance giving Flock members more time to feed, plus safety in numbers.

There are single species flocks and mixed-species flocks of birds- The type of food eaten determines the type of flock the birds from.

Cottontails and **White-Tailed Deer** have a white tails or “Flags” they raise when they are running away. This may signal predators that they have been seen.

Selective Pressure from predators on prey species is immense = Natural Selection- Major force in Evolution.

PLANT DEFENCES

PHYSICAL DEFENCES

Also called : **Mechanical Protection**

1) **Body Armor** = Tough Epidermis ("Outer Skin") = **Bark and Woody Stems; Trees, Shrubs.**

2) **Other Armor** – Spines(come from leaves), Thorns(modified branches), Prickles(come from epidermis), STINGING HAIRS

- new buds resemble prickles = **Automimicry**

Raspberry, Blackberry, Cactus, Thistle, Hawthorn

3) **Trichomes: Small hooked or Clubbed Hairs** = Dense animals impede small animals – Mites, Small insects. *Example: Mullein*

- Some Trichomes release Sticky Glandular Secretions = Glandular Hairs.

-No Trichomes on leaves in water, if water goes away it appears on leaves. – Inducible

One type – Separately stored Phenols and Enzymes, When animals brush them, they break open, contents mix like epoxy, create Glue-like ooze that hardens, also releases repulsive chemicals.

2) **Digestibility Reducers**

- When eaten, makes it hard for the animal to digest the plant; most have a dual purpose = Structural and Defensive.

A) Digestibility Reducers that are Structural Elements:

Plant Tissues have cells with Stiff walls that can thought of as Reinforced Concrete– Cement with **STEEL RODS** stuck in for support

1) **CELLULOSE + PECTIN AND HEMICELLULOSE** = Gluey cement with “RODS”.

Together these elements **give Rigidity** to cell walls

Benefit: Hard to digest even for Insects; *Omnivores and carnivores digest little, if at all.*

2) **LIGNIN** = Another structural agent, also Impregnates and stiffen cell walls

Provides Woodiness in stems and toughens leaves

Example: Nuts and cherry pits

3) **SILICA** = Cells walls strengthened by Silica, derived from Silicon – one of the most common elements in the Earth’s Crust ; Silica is found in **Grasses, Horsetails** Hard to ingest internally. – housed in phytoliths. **Calcium(Skunk Cabbages)** can also be used

B) Digestibility reducers that are not Structural

1) Tannin - Important and Common in **Woody Plants**

Free or stored in compartments; they're Astringent = Taste **dry**

Stored separately from Proteins in cells

When Leaves chewed, Released and Bonds to Proteins

Changes Configuration and Prevent **Digestive Enzymes** from working

Often more **Tannin** in **Older leaves** –Caterpillars stop eating when the Tannin build up.

2) Calcium Oxalate Crystals = in leaves of **Arum plants: Skunk Cabbage** and **Jack-in-the-pulpit** - **Calcium Oxalate** is Caustic, has a Corrosive taste – Secondary Metabolites.

3) Anti-Digestive Chemicals: Proteinase Inhibitors affect digestion by blocking the action of proteinase, the enzyme that digests proteins in animals. Not always present, sometimes produced when under attack.. **Wound hormones** are sent out by injured leaf, gets other leaves on the plant to produce inhibitors! Some plants under attack produce **Wound Hormones** that induce production and transport of **proteinase inhibitors**. (Prepare for the attack, load the weapons.

CHEMICAL DEFENCES: TOXINS

Tens of thousands of toxins known; many plants have several types = **Cocktail Blend**

Often Selectively stored in vulnerable tissues not yet fortified with **Lignin** or **Silica**.

Example: **Buds, Young leaves, Unripe fruit.**

- Contain Nitrogen or not

Some Toxins have **Dual Roles:** 1st= A Metabolic Role, 2nd = Defense

Others are **Secondary Compounds** or **Allelochemicals** = Toxins that are strictly defensive, no Metabolic Role.

A) Constitutive = Always Present

B) Inducible = Only produced when under attack ; components mix together when chewed.

Major groups of Toxins

A) **Terpenoids** – Over 100,000 Plant Species don't contain nitrogen

Most **Terpenoids** are **Bitter Tasting= Repulsion**; includes **Cardiac Glycosides** – Heart poison in **Milkweeds**.

- **Resins** (oleoresins) contain terpenoids (gum from tree) – sticky/glue,
- **Turpentine** – first liquid – evaporates creates a plug for the hole.
- **Poison Ivy/poison oak** : get in your skin and feel it. – urushiol. Every part has that urushiol except the pollen. – rash
- **Mints** have a very distinct smell to them

B) Alkaloids – Contain **Nitrogen**

More than **20,000** different **Alkaloids** identified include: **Cocaine, Nicotine, Caffeine,**

Strychnine, Morphine. Common in certain plant groups including **Buttercups** and **Asters**.

Nasty when Eaten; Symptoms include Irritation of the mouth, Salivation, Severe **Gastroenteritis** and **Diarrhea**.

Most are **Deterrents** and cause temporary illness, some **Alkaloids** very severely affect animals – some act like **Military nerve gases** affecting **Central Nervous System**.

- Water hemlock, most poisonous plant, purple asters

C) Hydrogen Cyanide (HCN) -

Taste Bitter and is extremely Toxic – so toxic that cannot exist freely in plant or animal cells so are stored in a form that is bound to other molecules. Harmless as long as the plant tissues stay intact but when animal chews the tissues the contents mix the enzymes and **HCN** is liberated (Thus an Inducible Defense). - produced on demand

As many as 1,000 species plants synthesize HCN: **Roses, Bracken, Clover**

Some have a mixture of chemicals – stored in special cells. Latex = laticifers

Phytoproteins – disrupting with digesting proteins – digestive track. Variety of forms

Hormones = Another group of plant defences

Some plants produce Hormones that are exactly the same as ones in animals

Insect growth hormones: Insects go through changes, Larva to adult

Two important hormones involved in this change:

MOULTING HORMONES (MH) and **JUVENILE HORMONES (JH)**

LARVA 1ST STAGE >---MH/JH--> 2ND STAGE>-- MH -->PUPA>--MH--> ADULT

Each must be present in right amounts at right time for normal development. Too much or too little of either causes severe problems. When an insect is ready to mature, it doesn't need the Juvenile hormone anymore (earlier stages)

1) Moulting Hormone = phyto**Ecdysone** (A number of types). Required for the shedding of the exoskeleton during **Moult** (Change). It allows insects to go through different **Larval** stages. It's not produced at Maturity so when insects eat plant-produced **Ecdysone** – get too much in their system; Results in Malformation, Sterility, early death.

Common in Ferns – Hardly ever eaten (Bracken. Rock Polypody study: (A Study found 25 milligrams Ecdysone in 2.5 Gram **GRAM** of fern root : The same amount was found in no less than 500 kg of insects.

2) Juvenile Hormone - Important in **early stages of development**; not produced at Maturity. . Some plants produce Juvenile Hormone. When the insect eats the plant, it keeps getting **Juvenile Hormone** in diet and the **Larva** cannot change to adult; Locked in “Childhood” Forever; cannot reproduce an overdose of **Juvenile Hormone** can also be lethal.

Balsam Fir is an example of a plant that produces “**Juvenile Hormone**”.

3) Some plants produce " Anti-Juvenile Hormone" It stops the **Juvenile Hormone** production too soon in the insect's development.

The insect becomes Adult-like too soon and is not ready to reproduce (**Yew** has this hormone).

These plants produce hormones that indirectly affect the animal's reproduction.

Other plant hormones that directly affect the Animal's reproduction:

Reproductive Hormones- estrogens: Found in **Clover**; Affect Sheep- Make labour difficult; Poor Lactation; Sterility, Fewer lambs are born. (There will be fewer predators of clovers).

Phototoxins are a light-triggered defence. **St. John's- Wort** produces these chemicals in glands in the leaves, flowers, and stems; When eaten, the chemical spreads in the blood through the animal to the outer surface of its body. Here it reacts with sunlight, making the skin super

sensitive to sunburn; Create stores, infection and even death!

Another more bizarre type of plant defence is one that is almost too amazing to believe. Some plants employ what might be called the **Mafia Defence** or perhaps “**Hell’s Angels Strategy**” because the plants call in predators to kill the attackers. They release Chemicals that Attract predatory insects.

Jasmonates : they float in the air, and land on other plants – reaction to occur. Ethylene works well in jasmonates. Go to next plant to get it responding. Command central. Animal attacks plant
Salicylic – Willow trees and poplar trees.

Chemicals are costly to produce. Just like animals, Plants want to conserve defence and minimize loss.

Plants attacked by microbe – attack them, kill them, and absorb them. Killing part of tissue – **autophagy**

Trees – compartmentalize - reduced response

They Advertise Defence:

A) **Warning Odours**

B) **Visual Warnings**

1) Visible Deposits of Toxins on leaf surface.

2) **Warning Colour: Aposematic** Coloration of Fruit -

Can change to tell the animals when to eat the fruit (Blueberries are green when bad to eat and blue when ripe, so that the animals know when to eat them) And unknowingly spread their seeds. If they’re eaten too soon, the seeds die so the plant protects the unripe berries that contain the seeds.

Plant Defences are just as complex, remarkable and Ingenious as those of animals.

Extrafloral nectaries – outside the plant to draw ants in.

Problem: Below freezing = Sub-zero temperatures make water freeze – it turns to ice. If water in cells of living animal, it freezes, expands and cells burst and the organism dies.

Two Different ways animals generate their internal temperatures:

Endotherms generate heat internally. *Examples:* **Birds and Mammals**

Ectotherms: Largely controlled by the temperature of the external environment.. *Examples:* Frogs, Snakes, Turtles, Salamanders (All of these are herps) **Insects**, and **Spiders**.

Adaptations

Two main solutions to the cold problem:

1) Stay Active and Deal with the Sub-zero Temperatures

2) Escape the Cold either by Leaving (= **Migration**) or by going dormant

Endotherms that remain active stay warm by :

A) Increasing body insulation to trap air and body heat.

Mammals: On the outside of their bodies grow extra hair – two coats

A) Outer coat gets thicker- Longer Coarser Guard hairs

B) Put on long johns = **Woolly/dense underfur** - *Example:* Foxes, Moose

Birds: Increase feather mass in two layers:

A) Contour Feathers outside**B) Down feathers underneath**

Some increase total feather mass by **50%** *Examples: Goldfinches*

Birds also Trap even more Body heat when Fluff up their feathers

Examples: Black-Capped Chickadees – Mere half inch feathers, from outside of feathers to skin difference of **90 Deg Fahrenheit**. (~50 C)

B) Putting on an Extra layer inside the body**Increase stores of body fat.**

1) **Subcutaneous Fat reserves** - in mammals, Subcutaneous white fat is important for Insulation; in **Birds**, Much of the fat is burned as fuel, heat is generated as by-product . Muscles move to generate heat. (shiver naturally)Fluffing up the feathers- trapping in the hot air.

2) **Mammals:** Store Brown Fat near heart and other vital organs.

Brown fat is a **high efficiency fuel** – Generates more heat when metabolized than does white fat = Heating pad. –burning for warmth

Examples: Voles and other small mammals.

C) Being a Warmer Colour

- White is Warmer due to lack of Pigmentation, Hollow pockets that trap air.
Examples: Polar Bear, Arctic Fox, Ptarmigan, Hare-27% more insulation, Snowy Owl
- Black retains less body heat, Especially when windy

As you go farther North, Animals tend to be paler = **Gloger's Rule**

D) Having a better body shape for retaining heat.

- Smaller extremities in North= **Allen's Rule**
Examples: Lemming Tails, Caribou and Artic Fox ears.

E) Reducing the surface area of body losing heat

- Lower or smaller surface area to volume ratio (Nearer to 1:1) **Bergmann's Rule**
- Tend to find larger or rounder animals farther North.
- Long thin animals have a large ratio (10:2 = 5 x more surface area, for example) While large round animals have a smaller ratio (2: 1 =2 x more surface area, for example)

Example: Lemmings in the North, Mice in the South

F) Reducing the amount of heat being lost through extremities.

- Rete Mirabile or “Wonderful net” = Countercurrent heat exchanger in extremities (feet and tails).
- Veins and Arteries branch into network at base of extremity and wrap around each other. When the veins carrying cold blood to the heart and lungs meet the arteries carrying warm blood to the outer body parts. Heat is exchanged between them.
- Blood arriving at the feet or tail is cold, often only 1 or 2 deg C.
- Reduces the temperature gradient between inside extremity and outside environment. This reduces the amount of heat loss and conserves energy.

Examples : Duck & Gull feet, Beaver tails.

Conserves energy in a second way. Blood returning to heart already partly warmed. Thus less energy to heat it up to body temp.

ADAPTATIONS TO COLD CAN ALSO INVOLVE BEHAVIOUR

1) **Thermoregulate** – Bask in the warm site, out of the wind, to absorb solar energy. **Examples:** Many Birds, Foxes, Other Mammals

2) **Warm Extremities** by tucking them in under feathers; extremity touches skin, feathers keep warm. **Example:** Ducks and Swans

3) **When sleeping, reduce surface area.**

- Fox, Wolves, Curl into a ball, Put tail over nose
- Birds tuck head under wing.

4) **Choose warm sites for sleeping or roosting.**

A) Coniferous branches covered in snow- less wind, traps body heat.

Examples: Many Birds such as Finches, Mammals such as Deer, Moose, Hares lay under conifer branches. That are snow covered- less wind under conifers, branches trap heat.

B) Cavities in Trees – Chickadees, Woodpeckers, Small Owls.

C) Use the snow – go in the snow at night for warmth - **Ruffed Grouse**

D) Small Mammals: Under snow in **Subnivean Space.** /Crowded, cave in, lack of oxygen.

Only a few Deg below Zero here, while it be -40 above the snow.

E) Use a Den: Beaver-sticks/muds build lodges, so do **Muskrats**-softer materials. Hole is created indirectly-breathing hole, causes warmth.

5) **Share body warmth – Huddle. Voles, Also flying squirrels.**

6) **Turn up the heat by Shivering:** Some birds generate more heat by increasing the muscle activity, this happens at night or during cold stretches. – Breast Muscle Huge- for Flight, Shivers to generate heat.

For Birds, Shivering is an important means of Thermogenesis.

7) **A Few Birds turn down the heat, enter deep called Torpor.**

Example: , Black-Capped Chickadees

- Let internal body temp fall – Chickadees drop internal temp 12 Deg C.
- Short-term, usually only overnight, if Temp falls too low, pectoral muscles kick in, shiver, raise temp (Like a Thermostat).
- Breathing can create heat

Not all animals stay active when the temperature drops. **Ectotherms** cannot because their body temps drop with environment. They go Dormant as body core temperature drops. They avoid freezing by most herps (**Reptiles and Amphibians**) become inactive.

They escape freezing temps by avoiding them by:

1) **Behavioural Freeze Avoidance** = Seek a site where temps are not below zero.

Snakes go underground in cracks, etc. below the frost line = the place where snakes are dormant = **Hibernaculum.**

Toads, Salamanders – Dig down below the frost line; **Turtles and Most frogs (Bullfrogs)**, Go to the bottom of Ponds where it does not freeze, Here their Metabolism slows down, they breathe through their skin.

Most **insects and other invertebrates** also go dormant but in areas where it is below zero they produce **Antifreeze**- let internal water temperature fall well below zero but it stays liquid. They add to their body **Antifreeze= Glycerol and Sorbitol = Cryoprotectants**. Many also clean out their gut, they void or get rid of particles around which ice might form.

Supercooling = When no ice forms in an animal's body and all body water stay liquid well below zero.

Supercooled animals usually are dormant in a sheltered site where the temperature is moderated. And they are out of the wind.

Example: Under bark, in crevices, on ground.

Best sites are near the ground under the snow.

Can be Dormant in any life stage

- 1) **Eggs** – **Underwing Moths, Praying Mantids** (Egg cases are called Ootheca).
- 2) **Pupal Stage** – Many **Moths and Butterflies** including **Silk Miths and Spinx Moths**.
- 3) **Adults** – **Angle- Winged Butterflies** (That's why we see them very early in the spring), **Ladybug Beetles** (see them in houses in the fall).
- 4) **Larva:** **Woolly Bears, Caterpillars**

Some insect grubs or larval stages overwinter in **galls**. – Enlarged structures on plants that contain animals.

Goldengrod Gall fly- Larve are Freeze-tolerant in Galls

Chorus Frog, Wood Frog, Spring Peeper, Gray Tree Frog – Stay near soil's surface , freeze, allow ice to form inside body but ice forms between the body cells, not inside the cells.

- 1) They use Cryoprotectant – They add Glucose to cells.
- 2) They control the ice formation by creating special proteins for ice to form around =

Nucleating sites.

When an animal freezes and survives = Freeze Tolerant

Also one reptile is Freeze-Tolerant= **Hatchling Painted Turtles** (not any older than hatchling)

Mammals: none are freeze- tolerant.

Some stay in winter and go Dormant.

TYPES OF DORMANCY

A) **Periods of Inactivity = Lethargy or Short-Term Dormancy**

Only when necessary during severe cold.

Porcupines, Racoons and Skunks – Stay in Dens.

Not true Hibernation, little drop in body temperature

B) **Longer-Term Dormancy or "Light Hibernation"**

**** All Hibernations display Periodic Arousal.**

Chipmunks- Heartbeat and Body Temp drop – Not deep Hibernation for they awaken,

eat and crap every few days.

C) Bats Different – Low Body Temp, High Heartbeat; Can have bits of longer dormancy periods – 30 days in Hibernaculum.

Bats Need the temperature to remain near freezing ; in caves, rock crevices, attics, mine shafts, some huddling occurs.

D) Bears – Also “Hibernate” – Better called Prolonged torpor or Dormancy.

- **Low heartbeat but high body temp.**
- Body temp does not drop much - **Low 30s C**
- Heartbeat drops to 8 Beats Per Minute.
- **Do not go below frost line.**
- **Dens very crude– Under Treefalls, some are lined.**
- **Aroused easily (they wake up easily)**
- **Do not defecate – rectal plug = Tappen**

Before Dormancy they put on a great amount of fat by eating lots of fruits and nuts (Especially Beech nuts)

F) Deep or True Hibernation:

Groundhogs – Largest mammal to undergo deep hibernation

- Greatly reduced metabolism

- Body temperature < **10 DEG C** **Heart Rate <10 BPM**

Hibernates below frost line in rolled-up position (lower the SA: VOL Ratio).

Never a complete winter-long sleep, occasionally awakens, then falls into sleep, maybe only once a month. Around here **Meadow Jumping Mice** and **Woodland jumping mice** are also deep or true hibernators.

For those animals that stay active, cold temps being second major problem:

Snow, Builds up, Gets deeper = **MOBILITY PROBLEM**

SOLUTIONS:

BEHAVIOURAL

A) Use of Subnivean Space – Small Mammals

B) Move to Areas of Less Snow : **Moose** go to Hemlock Groves

- **White-tailed Deer and Hemlock** or Cedars in very large concentrations Deer

years some have 12,000 -15,000 Deer

YARD: 1) There is food in low areas – Cedar Especially

2) Less snow, snow not compacted under trees easy to walk.

3) Safety in Numbers

C) Walk in tracks of others- **Wolves**

D) Use the body as a toboggan – **Otters, also Mink.**

PHYSICAL

A) **Long legs** - Moose

B) **Snowshoes** - Feet with large surface area – **Snowshoe hare, Fisher, Lynx; Ruffed**

Grouse grow their own snowshoes: Toe Scales grow in the fall

While many animals escape the cold by going dormant.

Others escape by leaving. If the movement is regular it is called **Migration**

Migration is mainly a response to food supply but solves the temperature problem as well.

Best known in Birds:

A few Ectotherms: **Monarch Butterfly ; Green Darner Dragonfly**

One Local Mammal = **Red Bat**

Vast Majority of Birds migrate especially Birds that eat Insects: Flycatchers, Swallows, Warblers.

Or that eat other invertebrates (*Example: Worms*) in mud – **Sandpipers**

Migration: Phenomenal event, often tremendous distances travelled.

Most **Songbirds** – Fly **500 KM (Several hundred miles) Each night**

Put down, Feed, Rest in **Stopovers.**

Sandpipers – Much greater distances – fly non-stop night and day

Semipalmated **sandpiper** - flies **4,000 - 5,000 KM (SEV thousand miles)** in 3.5 days

Former champion migrant is **arctic tern: FLIES 20,000 KM (12,000 MILES) Roundtrip**

Red Knot – Just found to fly non-stop **5,100 KM in 8 DAYS!!!!!!**

Most birds migrate at night; Less danger, Less wind, less dehydration (Bodies are air-cooled)

Some by day – **Blue Jays, Hawks, Hummingbirds, Blackbirds, Swallows**

Both by day and by night : Long distance Migrants – **Sandpipers**

Fuel is fat. WHY FAT NOT CARBOHYDRATES?

1) **Carbohydrates** - 1 GM needs 3 GM water (Thus more weight to carry)

2) **FAT** = No water needed to Metabolize

3) **1 GM FAT = 2X energy output of carbohydrate**

4) **Fat is stored easily**

All factors considered , **1 GM fat power = 8 GM Carbohydrates**

Fat is a highly efficient fuel

For most small birds, The fat is deposited in a mere **2 TO 4 DAYS** of Foraging!

Many birds double their body weight – **Semipalmated Sandpiper** in a mere **TEN DAYS**

Once fat is stored being good flyers Birds conserve valuable fuel by efficient flight.

Different types of flight used by different birds.

Flapping is a powered flight – use breast muscles, some Birds flap continuously: **Ducks, Geese, Sandpipers, Hummingbird.**

But flapping burns up energy

So some birds conserve energy by not flapping continuously.

Most energy efficient flight = no flapping at all.

Hawks Soar by holding wings out and using air currents to lift them up. May have to flap to rise up, then with wings open, glide down. Use rising air columns to lift them to a great height, then glide down to the next column of rising warm air = **thermal**.

When in a thermal, **Hawks** soar up in a circular fashion.

Use of rising air columns called **Thermalling or Thermal hopping**.

Geese fly in a “V” shaped flock because by flying behind the wingtip of the bird ahead it gains free lift.

Navigation: Migrational Compasses are used:

Daytime Migrants use the Sun, Landforms; Nocturnal Migrants (Most Songbirds). Use **Moon, Stars**

Likely most **birds** use the earth’s magnetic field: Likely detected by a photopigment. In the eye that interacts with the earth’s magnetic field. **We know a lot about migration because of banding birds at banding stations.**

Red eft does not use camouflage as its first main defence. – chemical defence

Mobbing is a defensive behaviour employed by blue jays

Bullfrogs, painted turtles, and northern water snakes share this feature – none of the above

If hibernation involves both the heart rate and body temperature falling to near zero, which animal is not a true hibernator: none of the above are true hibernators.

Together an animal’s eyes can see 350 degrees of combined field of views with 15 degrees of overlap. This animal is likely a mouse

Which of these measurements would be best for an animal living near the south pole. d) SA = 240; V = 220; TL = 50

An insect fails to moult and “stays young forever” this is because it had a meal of balsam fir.

The common and very bad tasting Frog Lizard looks just like the very common poisonous Jumping Frog and this looks just like the orange and blue delicious and harmless Eat-Me-IAM-Tasty Snake, which is really quite rare. This is an example of: batesian mimicry, mullerian mimicry, aposematic colouration.

If you ate purple asters, you would feel the effects of Alkaloids