

HIBERNATION METABOLISM

in

American Black Bears



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Hibernation Metabolism

Included below are Teacher's Notes for some but not all of the slides contained in the Hibernation Metabolism PowerPoint Presentation (DVD included in the Black Bear Box 7-12).

Additional information on Hibernation can be obtained at:

<http://www.bear.org/website/bear-pages/black-bear/hibernation.html>

Additional information on black bears can be found at www.bear.org and www.bearstudy.org.

A helpful resource listing link to many topics on black bears is:

http://www.bear.org/website/images/stories/education-outreach/resources/Black_Bear_Basics.pdf

METABOLISM



- Metabolism - life processes within animal bodies, including physiological responses to internal and external environments
- Anabolism - molecule building, energy needed
- Catabolism - molecule breakdown, energy released

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Slide 6:

Metabolism


Bears are heterotrophs and get their energy of metabolism from food. Unlike autotrophs (most plants, algae, cyanobacteria) who can build organic compounds, like sugars, from inorganic compounds like water and carbon dioxide, animals must ingest and then digest already made organic compounds into their simpler

building blocks by the process of hydrolysis (catabolism).

Building blocks of proteins are amino acids, building blocks of carbohydrates are simple sugars, and building blocks of lipids are fatty acids and glycerol. The process of catabolism releases the energy needed by the cell so that it can synthesize, through anabolism, the carbs, proteins, and lipids needed for the organism to function. The sum total of these life processes of catabolism and anabolism is referred to as metabolism.

HOMEOSTASIS

- Homeostasis - a state of balance in the body
- Living things need systems that control body processes (metabolism) so they can respond to environmental change and maintain an internal balance (regulation or homeostasis)
- What's going on in bears?

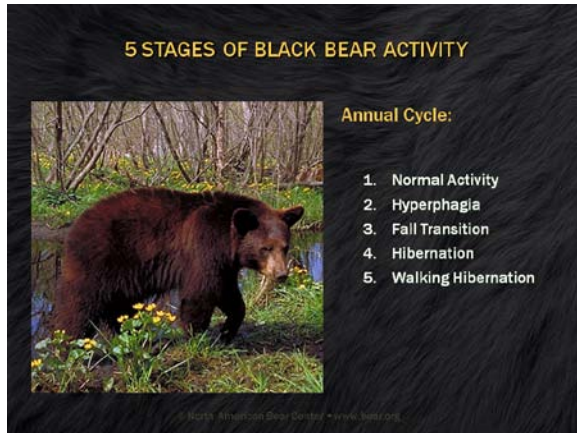


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Slide 7:

Homeostasis

Homeostasis is important in the functioning of all organisms. All creatures have very complicated systems that have to respond to various environmental and internal stimuli in order to keep the organism operating and regulating so it survives.



Slide 8:

5 Stages of Black Bear Activity

The annual cycle of black bear activity and hibernation has five stages:

The stages differ in biochemistry, physiology, appetite, and level of activity. The onset and duration of the stages are genetically programmed to fit regional norms of food

availability, which differ across America.

For example, around Ely, MN, fall food is scarce, so bears begin hibernating in September or October and remain in dens for 6 or 7 months until April. If supplemental food is provided to these bears in fall, they abandon it to begin hibernating on time, as they are genetically programmed to do. Bears around Ely usually continue hibernating through winter thaws.

The activity schedule is very different in eastern North America where acorns, hickory nuts, beech nuts, and other foods become available in fall and some foods remain available all winter. Bears there are genetically programmed to delay hibernation until late November or December and hibernate less than 5 months. Hibernation there is typically not as deep, and some bears emerge to forage during winter thaws. Food sometimes remains available throughout winter there, and some bears continue foraging throughout winter.




Slide 9:

State 1 – Normal Activity

Interestingly, during hibernation, bears don't eat, don't drink, experience little muscle breakdown, don't accumulate nitrogenous waste in blood, and don't defecate. Yet, if they are deprived of food or water during normal activity, they can become dehydrated, break down muscle, and accumulate nitrogen wastes in blood that may be

fatal. This is a great example of how homeostasis in bears regulates crucial processes during hibernation differently than they do during normal activity.

STAGE 2 – HYPERPHAGIA



- Hyperphagia – excessive eating to produce fat
- Mid-summer to fall
- May consume 15-20,000 kilocalories per day
- Stored fat provides energy for survival without eating during hibernation

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Slide 11:

Stage 2 – Hyperphagia

The period of hyperphagia varies according to local norms of food availability.

In Northern Minnesota hyperphagia is from late July through August to get ready for denning in September or October. Berry crops are at their maximum during this hyperphagia period. In

years of good berry crops, observations suggest that bears don't drink at all during 24-hour watches – obtaining all water needed from the berries they eat.

In areas with abundant tree nuts (acorns, beechnuts, hickory, etc.) the period of hyperphagia occurs later to coincide with ripening of the nuts.

STAGE 3 – FALL TRANSITION

- Body processes are preparing for hibernation – eating less
- Lack of energy (lethargy) – may rest up to 22 hours a day
- Adult active heart rates may fall from 80-100 to 47-60 beats per minute
- Sleeping heart rates fall from 66-80 to 22 beats per minute



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Slide 12:

Stage 3 – Fall Transition

Fall transition is a period after hyperphagia when metabolic processes change in preparation for hibernation. Bears voluntarily eat less but continue to drink to purge body wastes.

STAGE 4 – HIBERNATION

- Reduced metabolism in seasons of reduced food and cold temperatures
- Onset of hibernation varies with region, genes, food supply, and stage of life
- Fat bears, especially pregnant females, den first
- Hibernation is typically 3-4 months in eastern deciduous forests and 5-8 months farther north



Slide 13:

Stage 4 – Hibernation

Hibernation used to be defined in terms of body temperature reduction and by this definition bears were not considered to be hibernators. New knowledge of hibernation processes has led biologists to redefine hibernation as a specialized seasonal reduction of metabolism. Causes of this seasonal reduction of metabolism are

environmental pressures such as scarce food and low air temperatures.

Black bears are now considered highly efficient hibernators that don't need to eat, drink, urinate or defecate. Low body temperature hibernators like bats, chipmunks, and wood chucks can't do that. These smaller mammals have to periodically wake up by raising their body temperatures to over 94 degrees, move around and urinate. Some may even eat and defecate.

STAGE 4 – HIBERNATION

- In southern areas where food is available in winter, many bears remain active
- In eastern deciduous forests, some bears remain active in winters when acorns or beechnuts are abundant
- In northern regions where food is not normally available in winter, bears hibernate



Slide 14:

Stage 4 – Hibernation

Within regions of North America, bears are genetically programmed for the region as to whether they den or not. Weather makes little difference. In Northern regions, days may be 70- degrees and bears may be in dens or making dens.

Bears in northern Minnesota abandon available food to hibernate on time and hibernate so deeply that researchers can visit dens. Skinny bears hibernate so deeply that a researcher can touch them and not immediately wake them up. Bears in the deciduous forests of the eastern US may continue to forage all winter if food is available. Well-fed bears in PA are so alert in dens that the only dens researchers can visit without the bears running away are the dens of mothers with cubs. Bears in Florida often don't hibernate. Pregnant mothers, i.e., fat pregnant females, may drop their metabolisms the least but are the bears that consistently den up to give birth.



Slide 15:

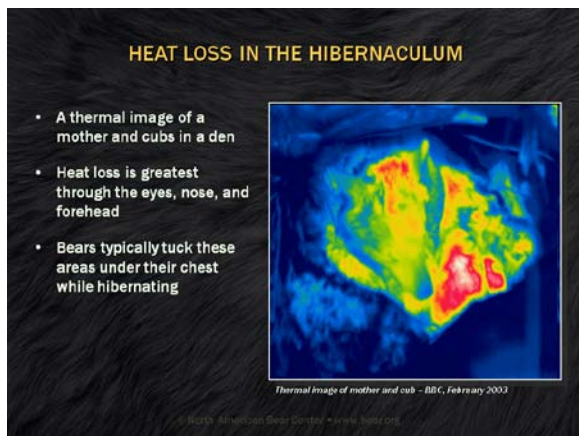
The Hibernaculum

Bears may begin and abandon several den sites throughout their foraging period. They remember exactly where these dens are and have been known to beeline to one of them if they are disturbed in the den they chose or if it becomes flooded or collapses. With some exceptions, they tend to choose places that are

relatively secluded, dry, and well drained.

Blacks and grizzlies will dig dens, but the long grizzly claws and greater strength makes them much better at it. There is little evidence that they dig snow dens like polar bears do.

Bears don’t urinate or defecate in dens. When females give birth, the afterbirth and cub feces are eaten by the mother and she recycles the nutrients. By keeping the den clean, it reduces odors and decreases the chances of a predator finding them.



Slide 18:

Heat Loss in the Hibernaculum

Black bears have far more insulative pelts and lower surface to mass ratios than small mammal hibernators. This means that heat leaves the body much slower than it would in an animal like a bat or chipmunk. Because the bear’s body heat is lost very slowly, it allows them to cut their metabolic rate in half and still make it through

winter. This way they can maintain body temperatures above 88 degrees, which is within 12 degrees of their summer body temperature.

UDCA TRADE
A Threat to Bears Worldwide

- Japanese synthesized UDCA in 1955
- Poachers still kill bears just for their gall bladders OR
- Capture bears, hold them in cages, and painfully extract bile from gall bladders daily
- Result: Asian bear populations in danger of extinction



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Slide 25:

UDCA Trade

This is more of a problem with the Asiatic Black Bear (*Ursus thibetanus*) than the American black bear.

See: www.traffic.org/species-reports/traffic_species_mammals10.pdf

HIBERNATION METABOLISM & PREGNANT FEMALES

- If females do not have enough fat, blastocyst may be absorbed or fetus aborted
- Cubs born about 3 months after implantation
- Bears produce smallest baby to mother ratio of all mammals, except for marsupials
- Why are cubs born so small and immature?



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Slide 28:

Hibernation Metabolism & Pregnant Females

A blastocyst (blastula) is the result of a fertilized egg (zygote) going through the process of mitosis until 16 outer cells surrounding a fluid filled ball is formed. If the female does not put on 3 to 4 times body fat by the time she enters the den, her ovaries may stop producing the hormone progesterone, which promotes the blastocyst to

develop. If progesterone shuts down, the blastocyst dissolves and she will not have cubs that year.