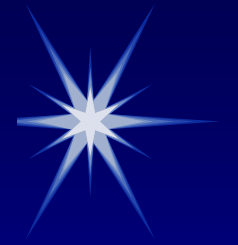
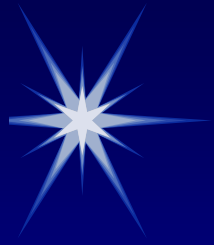


How Birds Fly



How Birds Fly





How Birds Fly



- Recall: The Earliest Thoughts about Flying
 - Took place before the days of science.
 - Before man began to investigate with carefully planned experiments, and to figure things out in an orderly fashion.
 - Men of that time were inclined to use their imaginations and just try things
 - Ancient man watched birds fly and their logical conclusion was that if birds could fly, man could fly if man imitated birds





How Birds Fly



When ancient man tried to fly by imitating birds, what did they not realize about birds?





How Birds Fly

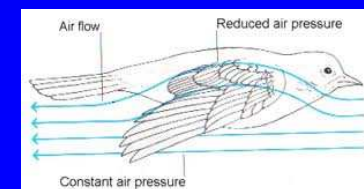
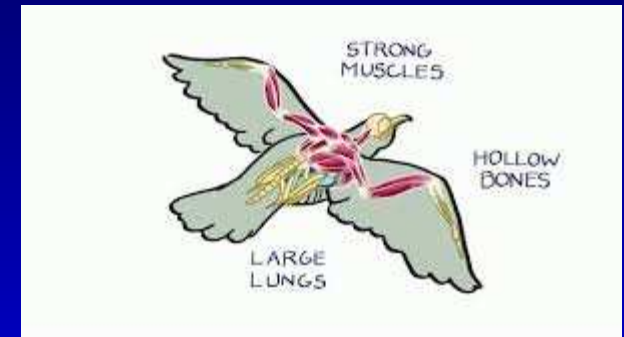


1. The physical features of a bird minimizes the effect of gravity
2. The bird's body is designed for flight
3. The wings of a bird provide the aerodynamic requirements for flight

How Birds Fly

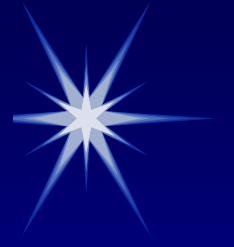


- (1) Physical features
 - Light, hollow bones
 - Light, smooth feathers
 - Light beaks vs. heavy, bony jaws and teeth
 - Light, but strong, stiff skeleton that provides firm attachments for powerful flight muscles
 - Light, streamlined body that provides the least resistance to air flow





How Birds Fly

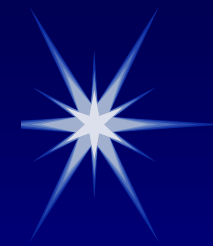


- (1) Other Issues that Affect Physical Features
 - Food is quickly used for energy so they rid themselves of useless weight quickly
 - Birds do not have bladders so they don't store urination, they release it as it develops
 - Their babies grow in eggs, outside of the body, so there is no extra weight during pregnancy
 - Birds have a large, strong breastbone, or sternum, that is crucial for attachment of muscles required for flight
 - Birds have wings





How Birds Fly

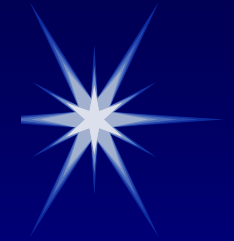


- (2) Bird Bodies are Designed for Flight
 - Birds have wings, which make lift possible
 - Birds have perfect center of gravity
 - Center of gravity: the distribution of weight in the center mass of an object to keep perfect balance
 - The bird's COG is between its two wings and between its head and tail
 - The bird's body has special adaptations to achieve the COG

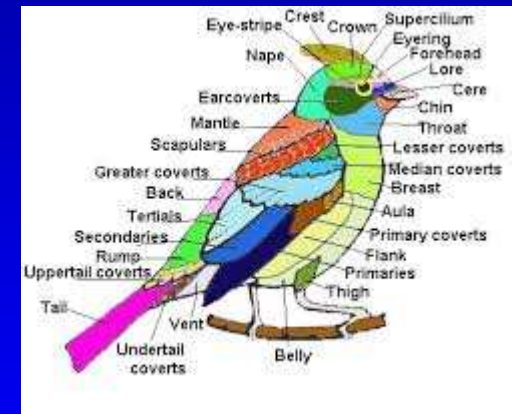




How Birds Fly



- (2) Bird Special Body Adaptations to Achieve COG
 - No teeth or nose, which would be too much weight too far forward
 - Very short tail and wing bones, which are attached to very light, and sometimes very long feathers
 - Their flat lungs sit against the back of their ribs (vs. human lungs located in our chest) and hold very little air
 - Air flows through their lungs into air sacs similar to balloons, that fill their lower abdomen, behind the center of gravity





How Birds Fly



(3) Aerodynamics Required for Flight

Aerodynamics: the way objects move through the air

3a. Lifting up into the air

3b. Staying up as long as needed or desired

3c. Controlling the direction of flight

3d. Landing safely



How Birds Fly



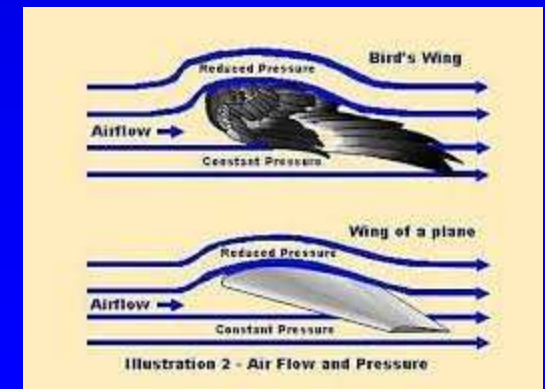
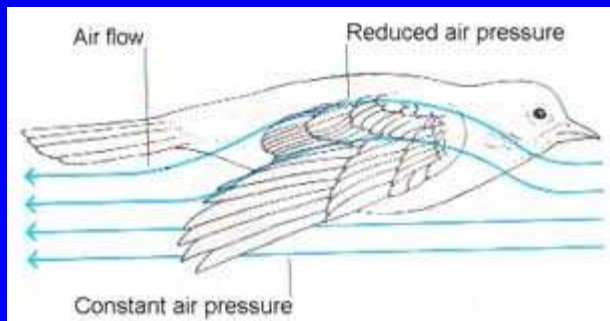
- (3a) How birds are able to achieve lift
 - Some run into the wind so that the rush of air beneath their wings create a lifting force
 - Some just jump off of high perches and use the updraft of the wind to create lift
 - Some use their powerful wing breast to create vertical lift, going straight up
 - The special shape of the bird wing allows lift
 - The bird wing's bones are in front, and are covered by a smooth layer of feathers that taper to the back



How Birds Fly



- (3a) How birds are able to achieve lift
 - Interaction of the air with the bird's wing shape
 - When the air comes straight toward the wing, the air flows faster over the top of the wing than it does under it
 - The fast air going on top of the wing lowers the pressure, or weight, on top of the wing
 - The slower air going under the wing lifts or pushes the wing and bird upward





How Birds Fly

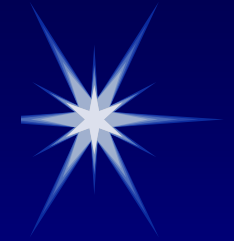


- (3b) How birds stay up in the air
 - Gliding
 - Soaring
 - Flapping





How Birds Fly



- (3b) How birds stay up in the air by gliding
 - Wings are held out in a still, steady position, without any flapping, to the side of the bird's body
 - As the bird moves through the air, its wings are held at a slight angle, deflecting the air down, which causes a lifting affect in the opposite direction
 - If drag occurs, the bird tilts forward, going into a small dive angle to keep forward speed





How Birds Fly



- (3b) How birds stay up in the air by soaring
 - To soar, birds glide/fly into rising air currents
 - Thermal air currents are created in spots where air is warmer than connecting spots; the warmer air is lighter than the cooler air and provides a greater lifting force
 - Updrafts are created when winds hit a physical barrier (like cliffs, mountains, buildings); the rushing air hits the barrier and goes straight up, creating a great lifting force
 - Wind heading toward birds with wings spread creates currents that help the bird maintain lift

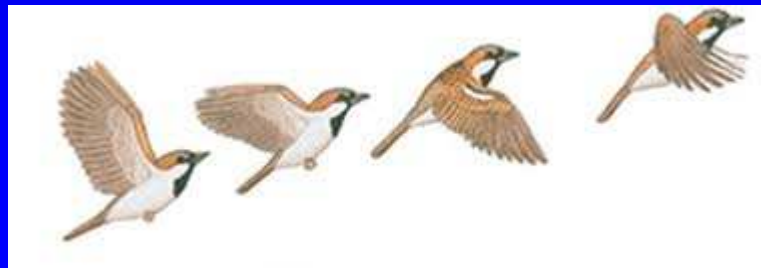




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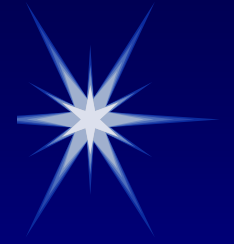


- (3b) How birds stay up in the air flapping
 - The up and down motion of the birds' wings propels the bird forward
 - When the wings flap downward, the air pressure is higher below the wing, pushing the bird upward
 - Birds must move forward fast to stay in the air when flapping





How Birds Fly



- (3b) Controlling the direction of flight
 - Some birds soar into thermals or updrafts with wings open, go as high as they wish, then pull the wings back to and glide into the direction they wish to go
 - Some birds fly into the wind for lift, turn slightly now and then to get to where they are going
 - Some flap and just point themselves in the direction they wish to fly





How Birds Fly



- (3b) Landing safely
 - Birds gradually change the angle of their wings to higher and higher positions, increasing drag, slowing themselves down
 - Birds then un-tuck their feet and legs from beneath their tummies and pick a spot on which to land

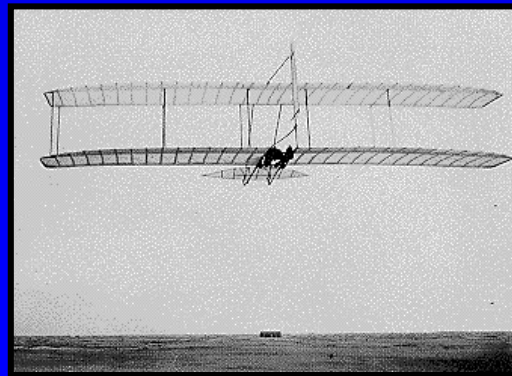




How Birds Fly



- When ancient man tried to fly by imitating birds, they did not realize and take into account that:
 - Birds were made to fly, but man was not
 - Man would need to build machines that had the flying qualities of birds in able to fly





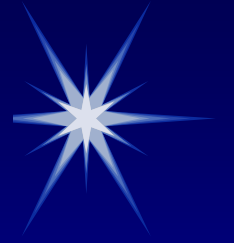
How Birds Fly



- Man did not realize that:
 - The physical features of a bird minimizes the effect of gravity
 - The bird's body is designed for flight
 - The wings of a bird provide the aerodynamic requirements for flight



How Birds Fly



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