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Guided Notes for Flight/Feathers/Migration Lecture

The dynamics of bird flight like all physical actions are governed by the laws of physics. In its simplest expression, flying is a balance between two sets of forces; \_\_\_\_\_\_\_\_ and weight, and thrust and \_\_\_\_\_\_\_\_. Weight is the result of gravity and is reduced as much as possible in birds by their anatomy. Lift is generated by the \_\_\_\_\_\_\_\_ of air over the wings.

Birds wings are not flat but are shaped like an \_\_\_\_\_\_\_\_\_\_ - concave. Air passes over or under the wing as the bird moves forward, or as the wind blows. The air that moves over the top of the wing has \_\_\_\_\_\_\_\_ to travel to get across the wing, thus it \_\_\_\_\_\_\_\_ up.



This effectively \_\_\_\_\_\_\_\_ the wing up. Meanwhile, the air going below the wing experiences the opposite effect. It \_\_\_\_\_\_\_\_ down, generates more \_\_\_\_\_\_\_\_\_\_ and effectively pushes the wing up. Hence a bird with air moving over its wings is pulled \_\_\_\_ from above and pushed \_\_\_\_ from below. The more curved the airfoil the \_\_\_\_\_\_\_\_\_\_ the lift providing the degree of curve does not impede the flow of air.

* + **Drag** is a \_\_\_\_\_\_\_\_ exerted on an object moving through a fluid. Try running against a high wind and you'll feel drag \_\_\_\_\_\_\_\_ you back in the direction of relative fluid flow. It creates a force \_\_\_\_\_\_\_\_\_\_ the motion of the object.

**Thrust** is only in true fliers by *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* (wing flapping), especially at the end of the wing. Thrust is induced in the \_\_\_\_\_\_\_\_ of the animal's flight, opposing the drag force. To fly at a steady speed in a completely horizontal direction, an animal must generate enough thrust to \_\_\_\_\_\_\_\_ the drag forces on it. Thrust is produced by flapping the wings which creates a \_\_\_\_\_\_\_\_ wake that has the net effect of \_\_\_\_\_\_\_\_\_\_ the animal forward.



A biologists may also look at \_\_\_\_\_\_\_\_ Loading. Wing Loading is the \_\_\_\_\_\_\_\_\_\_\_\_ between total body \_\_\_\_\_\_\_\_ and total wing \_\_\_\_\_\_\_\_. This can show the differences between birds with similar wing shapes but different sizes.

* + The \_\_\_\_\_\_\_\_\_\_ the wing loading, the larger the turning circle and larger the thermal “bubble” required for soaring to gain height.

Smaller species with \_\_\_\_\_ wing loading can utilize smaller thermals unlike heavy vultures that need larger thermals.

The \_\_\_\_\_\_\_\_ Ratio is the ratio of wing area2 divided by wing \_\_\_\_\_\_\_\_. It is used to show the different aerodynamic problems a bird might have.

A \_\_\_\_\_\_\_\_ aspect ratio indicates long & \_\_\_\_\_\_\_\_wings. These are used for gliding. Slower flight, slow turns.

A \_\_\_\_\_ aspect ratio indicates \_\_\_\_\_\_\_\_ & stubby wings. Used for quicker take-offs. Faster flight, more maneuverable.

Low Aspect Ratio of 3.0 to \_\_\_\_\_. Allows them to \_\_\_\_\_\_\_\_\_\_ into flight suddenly and are quite adequate for relatively \_\_\_\_\_\_\_\_ powered flight, but not good for \_\_\_\_\_\_\_\_.

Broad, \_\_\_\_\_ wings with an aspect ratio of 9.3 and the feathers at the ends separate out into \_\_\_\_\_\_\_\_\_\_ which help with minute controls (like airfoils) while the birds are gliding. These are basically terrestrial birds riding high above the ground using a variety of \_\_\_\_\_\_\_\_\_\_ to avoid \_\_\_\_\_\_\_\_\_\_\_\_.

\_\_\_\_\_\_\_\_\_\_ length wings with an aspect ratio of around \_\_\_\_\_. These wings are \_\_\_\_\_\_\_\_\_\_ to take off, but allow for a \_\_\_\_\_\_\_\_top speed and a little gliding. They are good for long distance \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Long, \_\_\_\_\_\_ wings with an aspect ratio of around \_\_\_\_ and higher and no fingers. These are good for \_\_\_\_\_\_\_\_\_\_ over the sea, close to the surface, using small changes in \_\_\_\_\_\_ direction.

   

Soaring or gliding birds may appear to hang in the air effortlessly, gaining height with barely a twitch of a wing.

Usually this is done by \_\_\_\_\_\_\_\_\_\_ birds because:

1. Gliding is easier the larger the \_\_\_\_\_\_\_\_ are.

2. \_\_\_\_\_\_\_\_\_\_\_\_\_ flight becomes harder the larger you get. Mass tends to increase far faster than length.

3. It’s harder, more stressful on the \_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_ to flap large wings.

Remember, 'for every action there is an equal and opposite reaction'. Understanding physics is important in biology; however, if all this is a bit complicated just remember that \_\_\_\_\_ birds with \_\_\_\_\_ wings make better \_\_\_\_\_\_\_\_\_\_ than small birds with small wings.

Physical obstructions like \_\_\_\_\_\_\_\_\_\_, mountains and large \_\_\_\_\_\_\_\_\_\_\_\_ all cause disturbances in air movement, including \_\_\_\_\_\_\_\_\_\_\_\_ of air. Over some lands the air is heated by reflection and radiation from the sun-heated earth. This produces the \_\_\_\_\_\_\_\_\_\_ updrafts that many of the large birds mentioned earlier use to keep themselves aloft.

Birds face \_\_\_\_\_ the wind to gain lift, but not \_\_\_\_\_\_\_\_\_\_.

Birds facing away from the \_\_\_\_\_\_\_\_ gives speed, but \_\_\_\_\_ of lift.



Over the sea, large physical objects and thermal updrafts are very \_\_\_\_\_. Instead, Albatross use small local updrafts caused by the wind meeting the \_\_\_\_\_\_\_\_. These updrafts are small and \_\_\_\_\_\_\_\_\_\_\_\_\_\_, so sea birds fly close to the sea \_\_\_\_\_\_\_\_\_\_, often riding along one wave catching the air that rises over it before \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ quickly to another. In this way, their flight is a \_\_\_\_\_\_\_\_\_\_ from one spot of rising air to the next.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ flight is a more complicated process. The bird's wing changes shape during both the up and down stroke. It also changes its \_\_\_\_\_\_\_\_ of attack depending on how much it presses down and how much it pushes \_\_\_\_\_\_\_\_\_\_\_\_\_\_. Flapping flight is basically \_\_\_\_\_\_\_\_\_\_ in the air with the added complication that it needs to generate \_\_\_\_\_\_ as well. If certain birds stop flapping their wings they better be about to land on a branch or they will fall to the ground.

Most species of birds do not flap their wings \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ during flight. Rather, they exhibit one of two [\_\_\_\_\_\_\_\_\_\_\_\_\_\_ flight](http://dbs.umt.edu/flightlab/intermittent.htm) patterns: flap-gliding and flap-\_\_\_\_\_\_\_\_\_\_\_\_. Mathematical models predict that flap-bounding is energetically \_\_\_\_\_\_\_\_\_\_\_\_ than continuous flapping flight at \_\_\_\_\_ speeds, while flap-gliding is more \_\_\_\_\_\_\_\_\_\_\_\_ than continuous flapping at \_\_\_\_\_ speeds. However, few species of bird exhibit both types of intermittent flight.



* + Parent birds begin to teach their fledglings the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of flying by remaining a short distance away from the nest during feeding \_\_\_\_\_\_\_\_\_\_\_ the young to step away from nest.
	+ Falls to the ground become more \_\_\_\_\_\_\_\_\_\_\_\_\_\_ as the young bird stretches out their wings. Short hops back to the nest become \_\_\_\_\_\_\_\_\_\_ flights.
	+ Bird parents \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ their brood to leave the nest for longer periods of time.

Some species actually adopt a \_\_\_\_\_\_\_\_ love policy, leaving the fledglings \_\_\_\_\_\_\_\_ to develop their own flying instincts.

**FEATHERS**

* + They are: highly-modified \_\_\_\_\_\_\_\_\_\_.
	+ Uses:
		1. Protection: When its cold, muscles connected to the feathers allow the bird to \_\_\_\_\_\_\_\_ itself up and trap air underneath. When birds are hot, they \_\_\_\_\_\_\_\_\_\_ the feathers to eliminate these heat-trapping pockets of air.
		2. Raincoat: Many birds apply \_\_\_\_\_ to the feathers from a \_\_\_\_\_\_\_\_ at the base of the tail (uropygial gland).The gland secretes an oil that the bird squeezes out with its bill and then applies to its feathers for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and also for inhibiting the growth of fungi and bacteria.
		3. Mating: Males are \_\_\_\_\_\_\_\_\_\_ colored to attract the female.
		4. Camouflage: \_\_\_\_\_\_\_\_\_\_\_\_ tend to be drab and brown in order to hide while sitting on their nest.



There are usually several hundred \_\_\_\_\_ in each web. These barbs are held together by tiny \_\_\_\_\_\_\_\_\_\_. There are microscopic \_\_\_\_\_\_\_\_\_\_ (barbicels) that help lock the barbs in place.

If 2 adjoining barbs are \_\_\_\_\_\_\_\_\_\_\_\_, the bird will draw the feather between its \_\_\_\_\_ and reconnect the hooks from one barbule to the other barbules’ flanges. This is done in “\_\_\_\_\_\_\_\_\_\_\_\_” to restore the entire feathers structure.

**\_\_\_\_\_\_\_\_\_\_:** Form the outer coverings of a bird's body, including the wing & tail feathers

**\_\_\_\_\_\_:** Layer of loosely structured feathers beneath contour feathers which help to trap air near the birds body for warmth. Nothing beats the warmth of down!

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_:** Loose & fluffy feathers similar to down feather; provides body insulation and increases the buoyancy of water birds.

**\_\_\_\_\_\_\_\_\_\_\_\_:** Small hair-like feathers with a few barbs at the tip of the shaft; they occur among the contour feathers to keep them in place during activities.

**\_\_\_\_\_\_\_\_\_\_:** Modified, vaneless contour feathers with only a few barbs at the base on a small, stiff rachis. They can occur around the eyes, nostrils, and in flying insect-catching birds (such as tyrant flycatchers & goatsuckers) around the mouth, called rictal bristles. aka “Feelers” in birds.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_:** Feathers that grow continuously and are never molted. The barbs at their tips constantly disintegrate into a fine, talc-like, water-resistant powder. Often abundant in birds that lack preen glands (Emu, Ostrich, Rheas, etc).

* + **Bird migration** is the regular \_\_\_\_\_\_\_\_\_\_ journey undertaken by many species of [birds](http://en.wikipedia.org/wiki/Bird). Bird movements include those made in response to changes in food \_\_\_\_\_\_\_\_\_\_\_\_\_\_, habitat or \_\_\_\_\_\_\_\_\_\_.
	+ Many bird populations migrate long distances along a [\_\_\_\_\_\_\_\_\_\_](http://en.wikipedia.org/wiki/Flyway). These flyway routes typically follow mountain ranges or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and may take advantage of updrafts and other wind patterns or avoid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ barriers such as large stretches of \_\_\_\_\_ water. The specific routes may be [genetically programmed](http://en.wikipedia.org/wiki/Genetic_programming) or \_\_\_\_\_\_\_\_ to varying degrees. Birds often use different routes to and from their different ranges.

The most common pattern involves flying \_\_\_\_\_\_\_\_ in the spring to breed and returning in the fall to wintering grounds in \_\_\_\_\_\_\_\_\_\_ regions to the south.

* + The primary advantage of migration is \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of energy. The longer days of the northern summer provide greater opportunities for [breeding](http://en.wikipedia.org/wiki/Breeding_in_the_wild) birds to \_\_\_\_\_ their young.
	+ Different Types:
		1. Within a species not all populations may be \_\_\_\_\_\_\_\_\_\_\_\_; this is known as "partial migration". Partial migration is very common in the \_\_\_\_\_\_\_\_\_\_ continents; in Australia, 44% of non-passerine birds and 32% of passerine species are partially migratory.
		2. The migrating birds \_\_\_\_\_\_\_\_ the latitudes where other populations may be \_\_\_\_\_\_\_\_\_\_\_\_, where suitable wintering habitats may already be occupied. This is known as *\_\_\_\_\_\_\_\_\_\_\_\_ migration.*

Within a population, there can also be different patterns of \_\_\_\_\_\_\_\_\_\_ and migration based on the age groups and \_\_\_\_\_.

Many of the \_\_\_\_\_\_\_\_ birds fly in flocks. Flying in flocks helps in \_\_\_\_\_\_\_\_\_\_ the energy needed. Many large birds fly in a V-formation, which helps individuals save 12–\_\_\_ % of the energy they would need to fly alone.

* + Sometimes circumstances such as a \_\_\_\_\_ breeding season followed by a food source \_\_\_\_\_\_\_\_ the following year lead to irruptions, in which large numbers of a species move far \_\_\_\_\_\_\_\_ the normal range.

For terrestrial birds, climatic regions tend to fade into one another over a long distance rather than be entirely separate: this means that rather than make \_\_\_\_\_ trips over unsuitable habitat to reach particular destinations, migrant species can usually travel at a \_\_\_\_\_\_\_\_\_\_ pace, feeding as they go.