(2) FLIGHT ADAPTATION (IN BIRDS)

→ Introduction –

Adaptation simply means adjustment with environment It can be morphological such as in shape, size and external feature of a living organism, anatomical involving adaptive modification in visceral organ.

- These adaptations are mostly the effect of environment in which the organisms lives. These modifications are both external and internal.
- For flying, adaptation is observed and classified by Mathew. It is also called as ~~volent~~ volent adaptation.
- There are so many things for which birds are adapted to support the flight.

eg anatomical
embryological
physiological
ecological.

FIG: BIRD SHOWING ADAPTATION FOR FLIGHT

→ Morphological adaptation for flight –

1. Shape –
– Spindle shaped body.
– Perfectly streamlined body provide least air resistance and hence easily propelled through air in the same manner as the fish swim in water.

2. Compact body – The equilibrium of body is controlled by heavy control region due to high position of light organ like lung associated with air sacs and low position of heavier parts like sternum, digestive organ and consequently low centre of gravity.

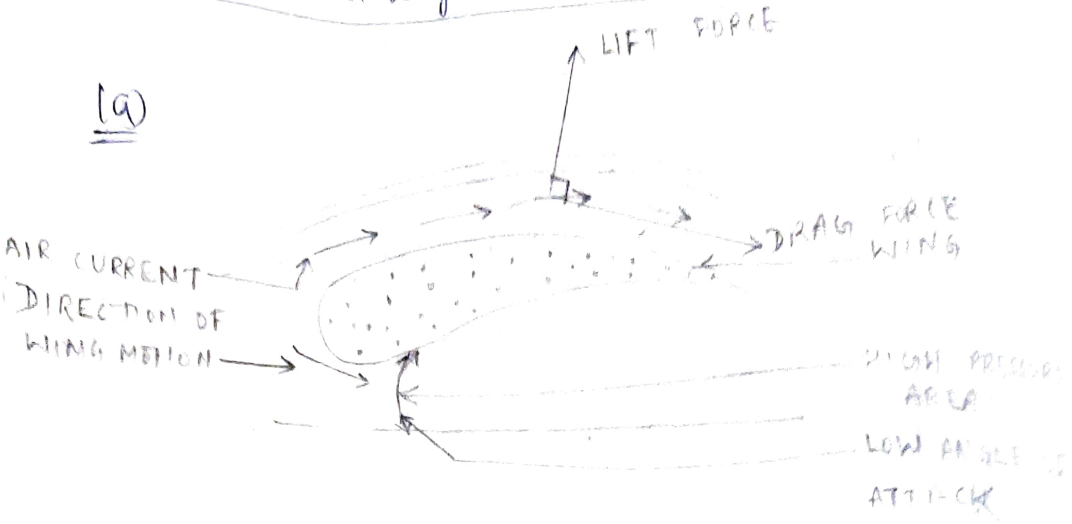
3. Body covering of feathers –
– Feathers are characteristic feature of birds.
– Feathers are smooth, backwardly directed and closely fitting to make body further streamlined.
– Feather gives insulation and help in maintaining homeostasis.

4. Forelimb modified into wing –
Wings are modification of forelimb for flight which are equipped with special flight muscle.
– Remiges – Elongated flight feathers of wing. (remix)
– Vane – Expanded membranous part of remiges.
– Wing propel the body up in air.

P.T.O.

Effect of a wing on air stream during flight

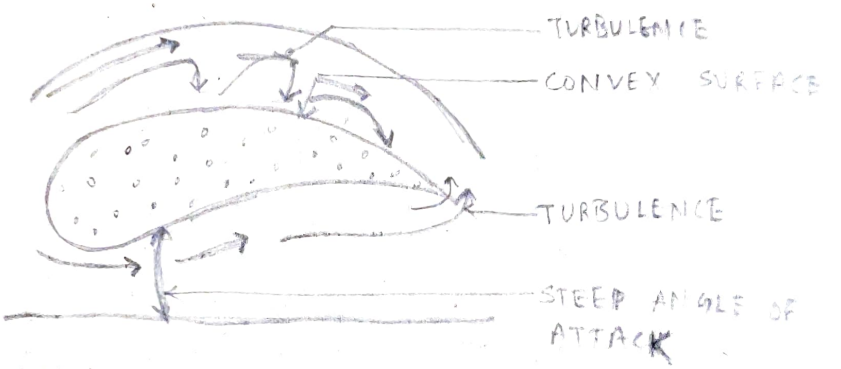
(a)



MECHANISM OF FLIGHT.

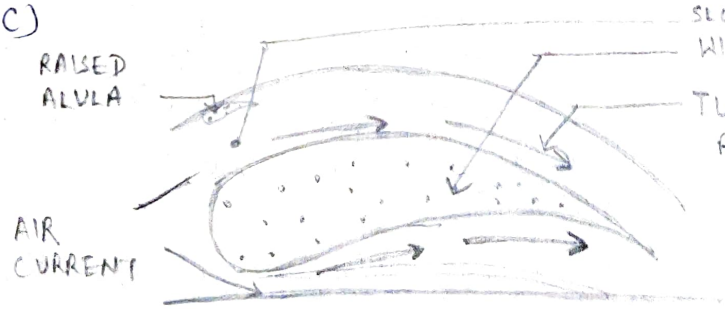
(a) Air moves rapidly along the upper surface of wing which reduces the pressure on upper surface and generate a force that is resolved into lift and drag force.

(b)



(b) Wing tilted sharply because air is in low pressure area, causing turbulence and reduction of flight.

(c)



Turbulence can be reduced by raising the alula. Alula forms a slot through which air moves rapidly and smoothly.

5. Short tail –
Short muscular tail bear rectrices arranged in a fan like manner. It also provide counterbalance during perching.

Retrices – Series of long stout

6. Beak –
Mouth is drawn out into horny beak which is used as forcep in picking up things. It equalise the need of forelimb.

7. Mobile neck and head –
Mobility of neck and freedom of movement of head is of multipurpose use.

8. Bipedal locomotion –
– Two hind limbs act as locomotary organ. These also support to body weight.
– Bipedality is common character of both flying and flightless bird.

9. Integument –
Loose skin. It is responsible for extensive movement of musculature (skeletal).

10. ~~Large muscle of flight~~ Perching –
Hind limb is modified for perching also. Here muscles are well developed and help in perching. As the bird, settles down on the tree, bending of leg exert a pull on flexor tendon which make the toes anatomically to flex and to grip the perch.

Anatomical adaptation for flight

1. Flight muscles -

Action of wing are controlled by flight muscle, which are developed very much while muscle of back remain greatly reduced. Breast muscle are well developed. Total flight muscle bear 1/6 of total body weight.

Wing is depressed by enormous - Pectoralis major
" elevated " " - Pectoralis minor

In addition,

Accessory muscles
Tensor muscles
also present.

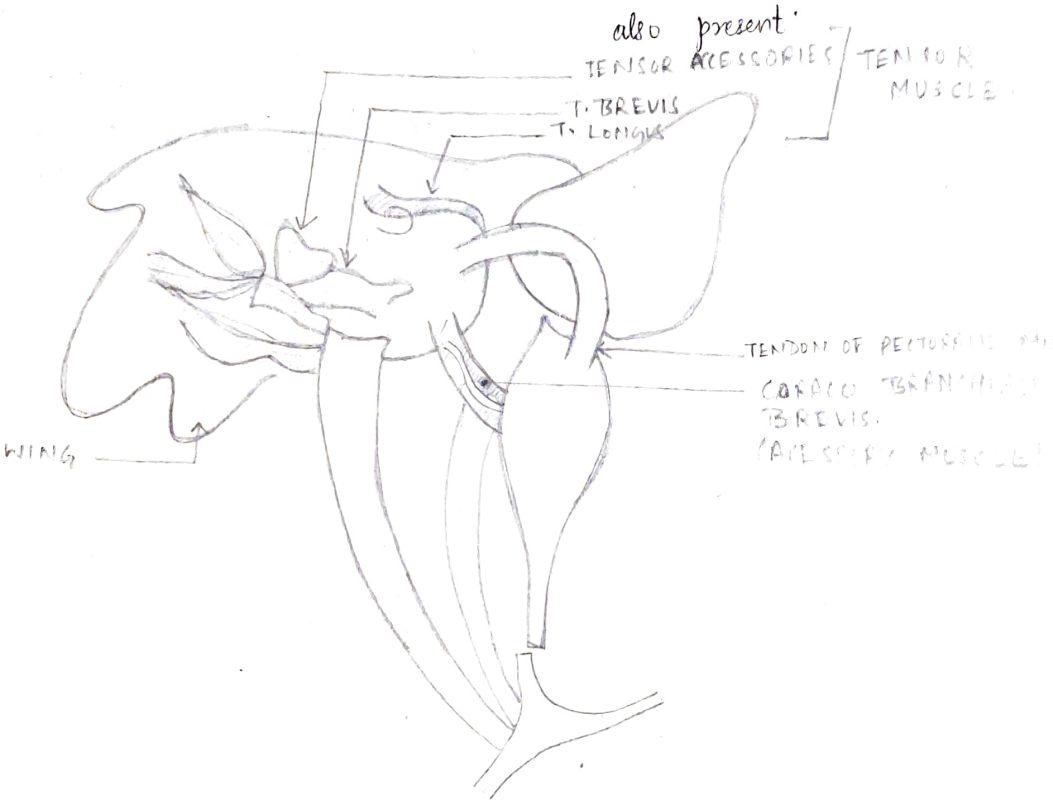


FIG: SHOWING FLIGHT MUSCLES IN BIRDS

2. Exoskeleton -

These form the smooth covering which form the body streamlined and reduces friction to minimum.
These outer covering maintain constant internal body temperature making the birds homeothermous.

3. Endoskeleton -

The fusion of bone built with smallest amount of material after the hollow - girder principles combines strength with lightness which is very much useful for flight.

- Most of the bones are pneumatic (hollow internally) and filled with air sacs instead of bone marrow.
- Skull bones are light and most of them firmly fused together.
- Uncinated processes of thoracic ribs help in providing compactness, necessary for flight, by concentrating mass.
- Heterocoelus vertebrae confer great flexibility and all birds can move through the neck through 180° which help in preening feathers in all parts of body.
- Shortening of caudal vertebrae and formation of pygostyle assist stability of body in air.
- Absence of mid ventral symphysis of pubis and ischia result in more posterior displacement of viscera, shifting the centre of gravity of body nearer to hind leg.
- The sternum is greatly expanded and bears a large mid ventral ridge c/a keel for attachment of major flight muscles in flying bird. Sternum is also called breast bone.

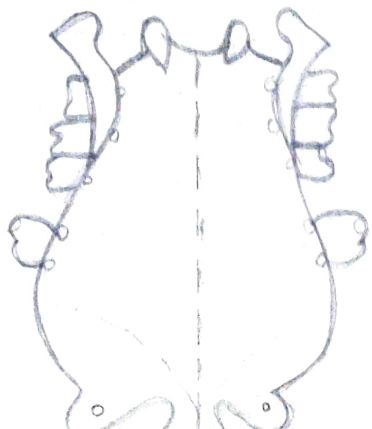
* ~~Kelt~~ Keel is absent in flightless birds.

- The skull -
Skull bones are light and sutures below bones are obliterated. Teeth are replaced by large horny beak to lighten the skull.

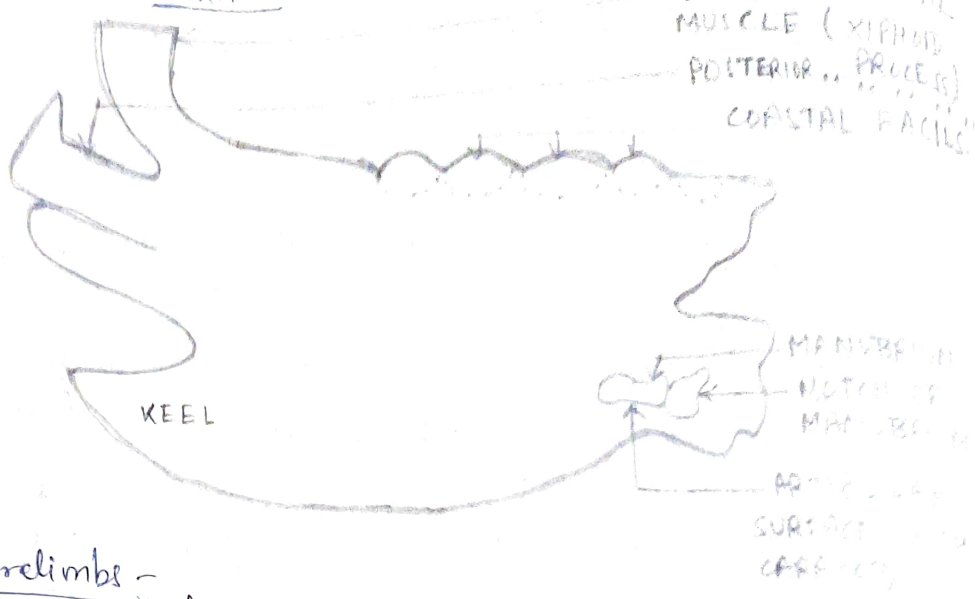
- Fused thoracic mass -
All thoracic vertebrae except the last one fuse together into a single mass.

- Synsacrum -
Last thoracic, all lumber, sacral and few caudal vertebrae fused to form synsacrum which provide a compound plate like girder to support entire wt. of body.

- Vertebral column -
Terminal caudal vertebrae fused to form a short pygostyle to which tail is attached.



—Fig:— STERNUM.

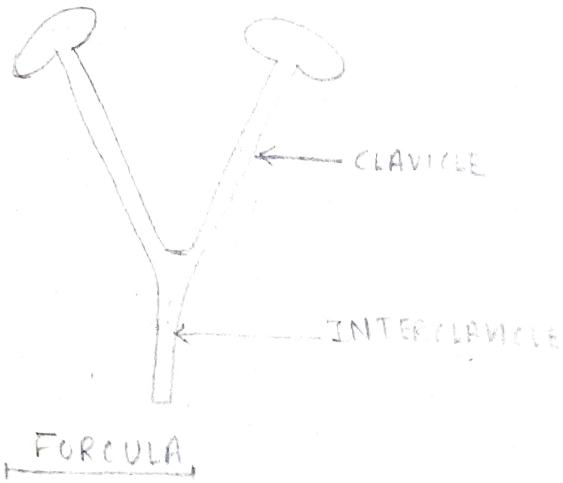


~~→~~Forelimbs —

Skeleton of forelimb is completely modified. There are only 3-digits which are more or less fused.

—Forcula—

Clavicle and interclavicle are fused to form forcula found only in flying birds.



→ Physiological adaptation for flight —

1. Digestive system —

Rate of metabolism in birds is very high, food requirements are great and digestion is rapid.

— Here food should be of high calorific value largely ~~used~~ utilised with minimum indigestable waste.

— Gall bladder is absent.

— Rectum is very small and faecal matter is not stored. It is because that flying bird can't bear extra weight of faecal matter.

2. Circulatory system :-
- Rapid metabolism and warm bloodedness requires more O_2 supply and efficient circulatory system.
- Avian heart is relatively large and completely divided in four chambers.
- Double circulation of blood i.e. found
  i.e. arterial circulation and
  pulmonary circulation.
- One ♦ right systemic arch is functional.
- High proportion of Hb. is present in RBC.

3. Warm bloodedness -
- These are warm blood animal and homeothermous
- They maintain a constt. body temp. of 40 - 42°C.
High temperature of body is necessary for flight requiring great output of energy.

4. Uricotelic excretion -
- Urinary bladder absent.
- Water of excretory fluid is reabsorbed in renal tubule of nephrons
- Coprodaeum of cloaca is best suited for reabsorption of water.
- Here urine is produced in semisolid form and excretory product is uric acid.
- Water restoring is main view in bird's excretory system.

5. Brain and sense organ -
- Sense of sight is well developed and olfactory system is reduced.
- Eye occupy a large portion of head
* Both eyes together are heavier than brain.
- Ability of accomodation of eye is very rapid and specialised.
- Cerebellum is much developed and convoluted.
- Enormous development of corpus striata in cerebrum gives extrastability during flight.

6. Single ovary -
- Only left ovary is functional in female birds.
- This reduces the body weight which aid in flight.

7. Air-sacs and respiration -
- Inelastic lungs.
- Provided with air sacs.
- Air sacs secure more perfect aeration of lung and help in internal perspiration, thus helping in regulation of body temperature.

* Avian lung are completely emptied with each breath. There is no residual air remaining
- Flying movement of wings contribute to respiration by compressing and dilating the air sacs.
- Thus birds can breath more easily during flight than other times.
* There are 9 air sacs associated with each lung.

Mscln -

* During flight, bird has to depend mostly on sense of sight. Therefor, eyes and optic lobes are well-developed.
* Organ of smell are poorly developed, therefor olfatory lobes are reduced.

→ Fig: Respiratory system of pigeon.