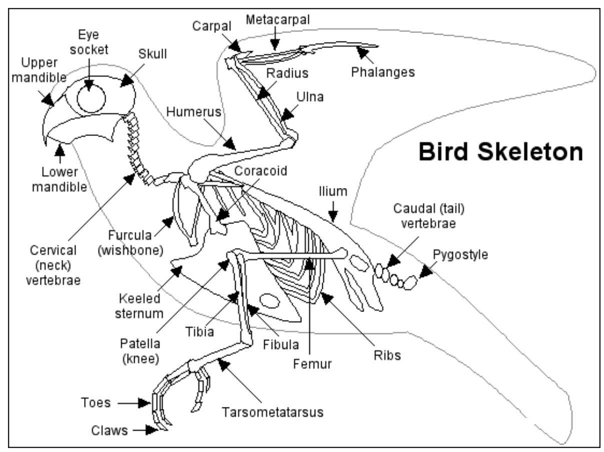
BIRD NOTES by Rick Pyeritz

They hover, swoop, and flutter, soar and glide:
On beating wings, they climb to heaven's height:
On unseen currents of the air they ride
Secure in space, in mastery of light.
Joel Peters

Earth-bound cold-blooded reptiles had to evolve many changes in order to become the warm-blooded flying machines we know today as birds.

Six Basic Changes from Reptiles to Birds

1. **Development of flight mechanism**—the most obvious change is that of the presence of feathers. Although it is not positively known, most scientists think that bird feathers evolved from reptilian scales. Not only of importance for flight, feathers play a vital role in thermal regulation. The Archaeopteryx had many of the characteristics of a reptile but had very well preserved outline of feathers on the wings and tail. An enlarged keeled sternum anchors the large flight muscles that empower the wings.



2. **Reduction of weight**—For birds to utilize its flight feathers and muscles, the bird had to become light as possible. This was accomplished by the bones becoming hollow and having interior struts for support. Several vertebrae were eliminated as well as teeth and some bones of the jaw. The right ovary and oviduct are absent and gonads atrophy during the non-breeding season.

3. **Increased rigidity of skeleton**—with the development of large flight muscles, the chest needed to be protected from the force generated by flight. This was accomplished in birds by fusing a number of bones which strengthened the skeleton without adding weight. The bones of the hand and wrist, which support and maneuver the large primary flight feathers, were reduced in number and fused for extra strength. The large coracoid bones braced the shoulder from the sternum. The clavicles were fused, forming the furcula (*wishbone of a bird*). This structure compresses and rebounds like a powerful spring in rhythm to the beat of the wings.


Allosaurus skeleton

Horizontal projections off each rib overlap its neighbor, strengthening the chest cavity known as uncinate processes. Fused tail vertebrae form the pygostyle which supports and controls the tail feathers.

4. **Bipedal locomotion**—as the reptile's forelegs developed into wings, the hind legs increased their ability to land, perch and walk. The last thoracic, all of the sacral, and six of the caudal vertebrae are fused into a synsacrum which joins the inner walls of the pelvic girdle and helps stabilize the pelvis for landing and walking. Fusion and elongation of the reptilian tarsal and metatarsal bones of the foot give rise to the tarsometatarsus of the bird. From this bone extend the four digits on which the bird walks.

5. **Increased metabolism**--the increased energy demands required of the two large flight muscles, the supracoracoideus (pulls wing up) and the pectoralis thoracicus (pulls wing down) require a hot engine ($107^o – 112^o$). To meet the energy demands of these muscles, birds need lots of oxygen and blood. Blood is supplied by the enlarged brachial and pectorial arteries, and oxygen by a system of air sacs which assures that there is no mixing of oxygenated and deoxygenated blood as occurs in reptiles. Supporting this requirement of increased energy demands is a 4 –chambered heart, high blood pressure, and high blood sugar levels.

6. **Others**--despite the reduction and fusion of its elements, the bird skeleton retains flexibility. The cervical vertebrae are not fused. A unique feature is that the first cervical vertebrae, the atlas, has only one point of contact with the skull which allows the bird to rotate its head more than 180^o.

Archaeopteryx figure

The above changes took millions of years to evolve. Fossil finds are few to document intermediate stages of evolution.

Questions and/or suggestions email me at eapyeritz@gmail.com.