Transportation Costs: Why does it pay to fly?

Minimum Cost of Transport = kcal/g body mass/km traveled


What are the differences & similarities in flight in birds & bats?

Describe 4 skeletal adaptations that aid flight, but evolved before birds began to fly. What features are new in birds?

- Fused clavicles = furcula
  - Larger brains!
  - Short, stiff trunk
  - Carpometacarpus
  - Synsacrum
  - Pygostyle
  - Keeled Sternum
  - Long arms
  - Strong ankle joint, in middle of tarsals
  - Semilunate carpal & “swivel” wrist
  - Derived Theropod: a Maniraptor
  - Large sternum (may be slightly keeled)
  - Large clavicle
  - Large acromion & coracoid processes
  - Rotated hip

How is a bat’s body designed for flight?

Swartz & Konow, 2015

Swartz & Konow, 2015

Cheney, Ton, Konow, et al. 2014

Kardong: Ch. 9:358-371; 10:404-407
Compare the designs of bird & bat wing bones

Why are a bat's terminal finger bones thin & soft?

Cartilage & Unmineralized collagen
3rd phalange
2nd phalange

What are the advantages of pneumatic bones?
(birds and also in many theropods)

Adult T. brasiliensis

Growth

Swartz & Middleton, 2008

Turkey Vulture hand bones

How do bird & bat wing bones differ in density?

Which group has the highest % of skeletal mass?

Do birds or bats have the most dense bones, on average?

How do muscles in the wing membranes develop?

Red: 2nd branchiomerich arch muscle progenitor.

Orange: migrating forelimb muscle precursors

Magenta: migrating hind limb muscle precursors

Tokita, Abe, & Suzuki, 2012

How do flight muscles in a bat differ a bird's muscles?

Acromiodeltid

Supraspin.

Clavodeltid

Pectoralis

Subscapularis

Serratus ventralis

Depressors (Adductors)

Levators (Abductors)
What is the evolutionary origin of the infraspinatus & supraspinatus muscles?

Embryonic development of Supraspinatus & Infraspinatus in an opossum

Lizard: deep shoulder muscles

Bird & Bat Wing Tendons: Springs or Strings?

% of wingbeats showing phase lags (as % of wingbeat duration) between triceps fascicle length change & elbow joint position.

Earlier work showed that shortening of supracoracoideus fascicles in pigeon precedes upstroke by > 10% of wingbeat cycle.

Who is the cutest of all?

Where are the major flight muscles in a bird? How do they work?

Hypothesized migration of the insertion of supracoracoideus, to dorsal on humerus

What are the advantages of a keeled sternum?
1. Explain how the wings of birds & bats use mechanical springs to aid flight.

2. What are the shared derived traits present in Theropods that had adaptive value when flight evolved? Compare the skeletal modifications & benefits of the designs for flight seen in flying birds & bats in trunk length, sternum, pectoral girdle, & wings (relative sizes of elements, fusion of bones, ...). Are bat & bird wings homologous or analogous? Explain.

3. Why are the terminal phalanges of a bat thin & non-mineralized? What are the sources for the muscles that enter the wing membranes. Describe the embryonic sources for the muscles that enter the wing membranes.

4. Describe 2 differences between the adductor & adductor wing muscles of bats vs wings of birds. Name 1 wing adductor (depressor) & 1 adductor (levator) muscle for birds & 2 adductors & 2 depressors for the bats. Explain how the wings of birds use mechanical springs to aid flight.


