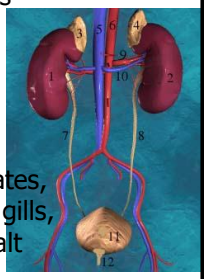
Urinary system

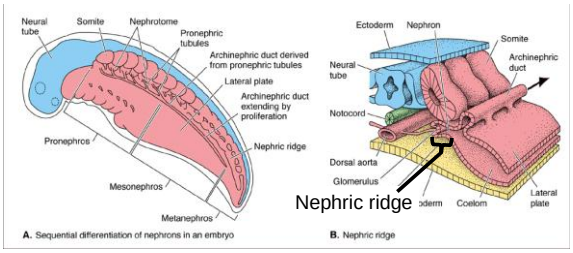
- Eliminates products of metabolism including nitrogenous wastes
- Regulates water, pH and ion balance



Kidneys present in all vertebrates, but exchanges can occur at gills, skin, liver, and specialized salt glands.

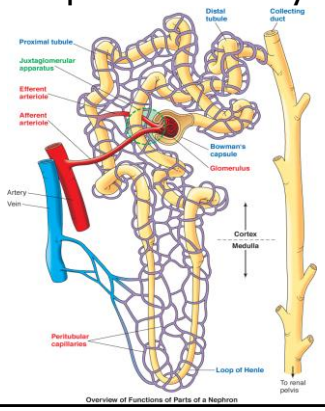
Renal development in vertebrates

- Development is again used for comparisons among our different vertebrates

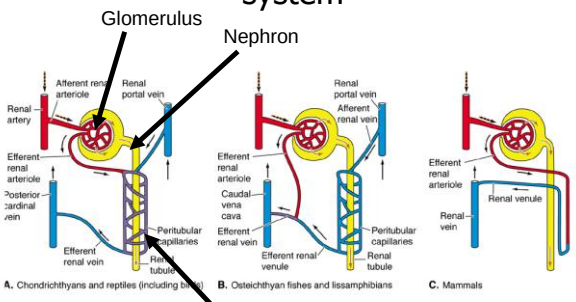


p.633

Nephron anatomy



Peritubular capillaries & renal portal system



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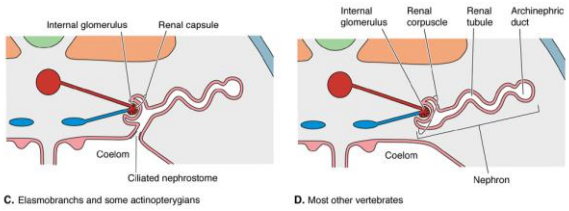
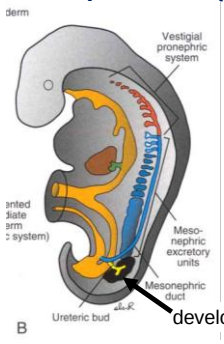
Nephron evolution

- Examination of larval or early vertebrate groups suggests nephrons evolved from pockets of coelum



Kidney development and evolution



Pronephros (anterior)-

Mesonephros (middle) -

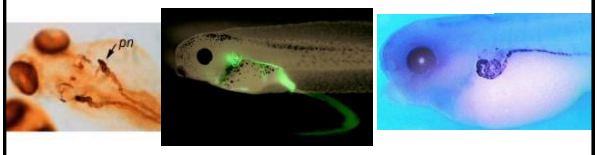
Metanephros (posterior)

developing metanephros

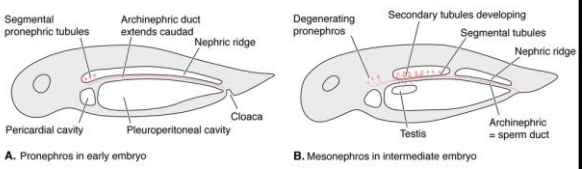
Kidney development and evolution

Pronephros - temporary, few tubules, possibly segmented. Non-functional in amniotes

Archinephric duct - drains into cloaca

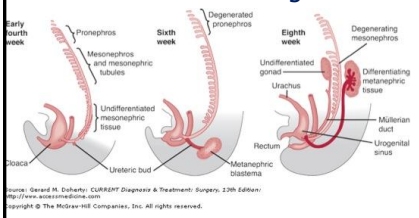


Kidney development and evolution



Kidney development and evolution

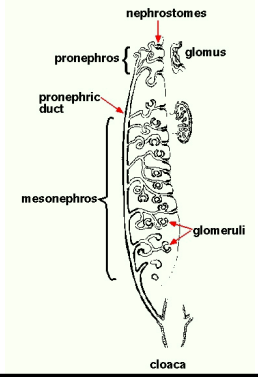
- Humans have a functioning mesonephros about 25 days after fertilization. When less than 5 mm long



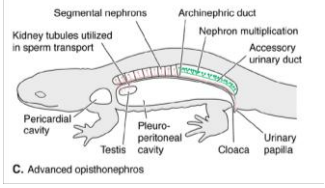
Kidney development and evolution

Mesonephros - develops posterior to pronephos, nephrons tap into archinephric duct

First nephrons are segmental and associated with gonad



Kidney development and evolution



caudal end of shark kidney

Anamniotes: Opisthonephros = mesonephros + caudal nephrons

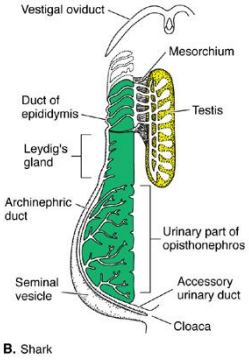
Caudal kidney forms multiple nephrons, produces most urine

Kidney development and evolution

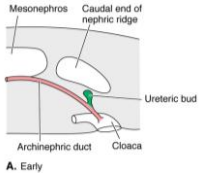
In male sharks, cranial kidney has no glomeruli and conducts sperm from testes

Middle kidney modified to secrete seminal fluid

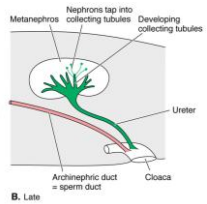
Fig 21-12

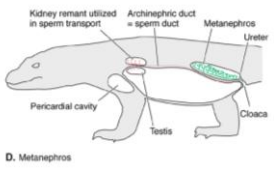


Kidney development and evolution



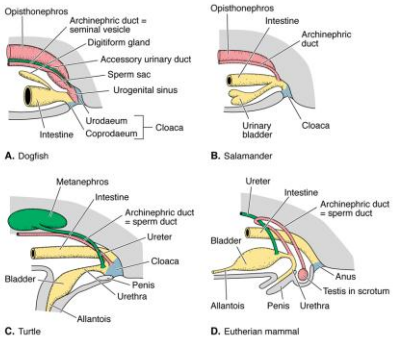
Amniotes





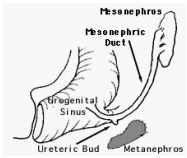
Cloaca and bladder

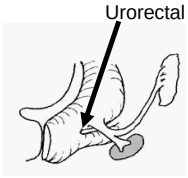
- Amniotes: bladder, urethra develops from allantois

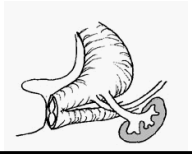


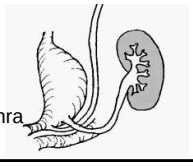
Cloaca and bladder

- Fate of cloaca in most mammals

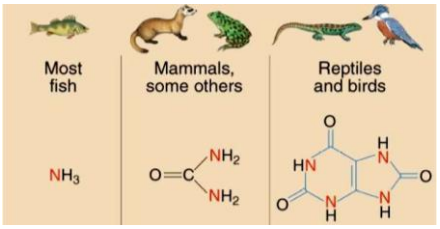








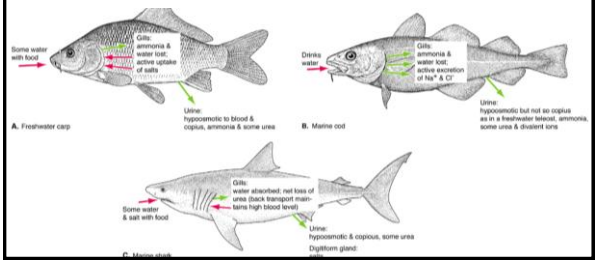
Nitrogen excretion



Ammonia Urea Uric acid

Gill excretion

- Gradient for ammonia to leave
- Gradient for salt, H_2O depends on environment
- Active uptake or excretion of salts

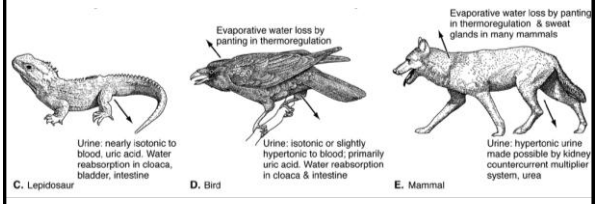


Evolutionary trends

- Tetrapods – with loss of gills, a method of waste removal is lost
- Endothermy – High metabolism increases nitrogenous waste, more nephrons needed

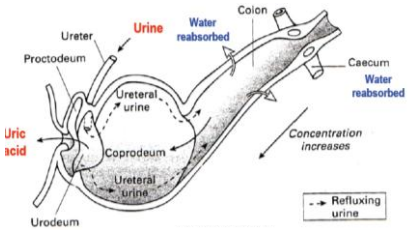
Evolutionary trends

- Tetrapods – need to concentrate urine
  - Use uric acid
  - Concentrate urea

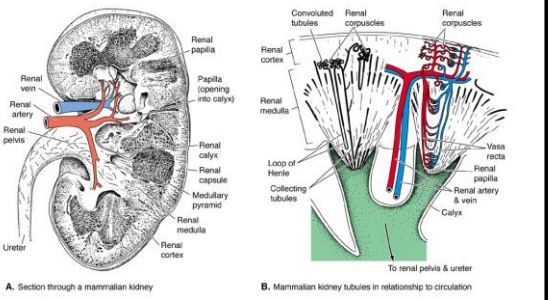


Reptile, bird excretion

- Most birds, reptiles cannot concentrate urine in their kidney as mammals do
- Concentration occurs in cloaca, reverse peristalsis to colon



Mammals and their lovely hypertonic urine



A. Section through a mammalian kidney

B. Mammalian kidney tubules in relationship to circulation

Desert mammals

- Medulla region extends to increase length of collecting ducts for reabsorption

Living with saltwater

- Birds, reptiles can have accessory salt glands
- Sea mammals can excrete urine more concentrated than salt water