

Evolution of Urogenital System. ①

In vertebrate kidneys and gonads remain functionally correlated, However the two systems are intimately related morphologically in vertebrates because the male urinary ducts are also used for discharging gametes. For this reason, it is more convenient to treat and describe the two together as the urogenital system.

Evolution of Vertebrate Kidney and ducts.

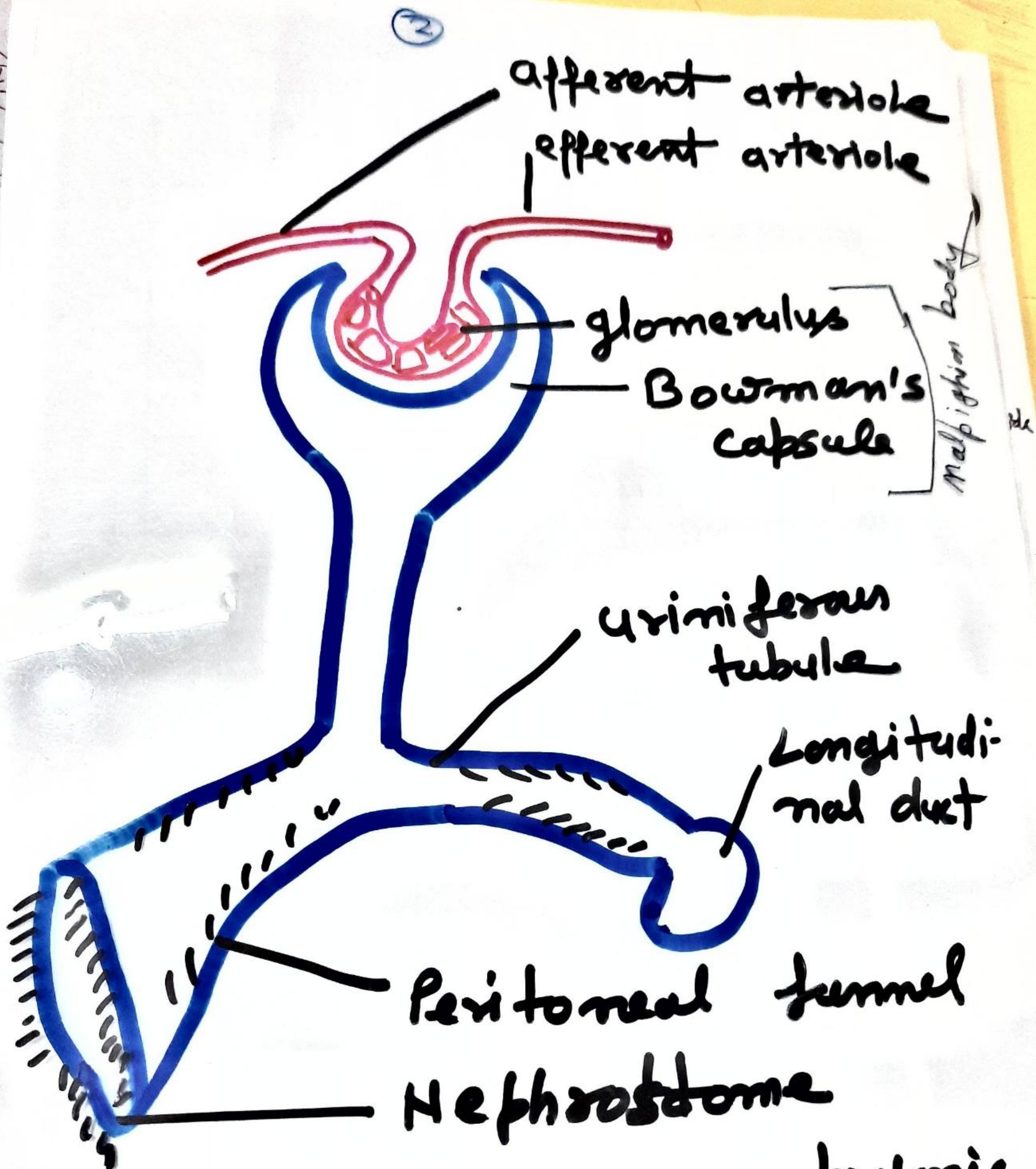
Basic structure of kidney \Rightarrow
(Embryonic kidney or Hypothetical primitive kidney)

Vertebrate kidney is a pair of compact organ

lying dorsal to coelom in trunk region one on either side of dorsal aorta. Each kidney is composed of a large number of units called uriniferous tubules or nephrons.

A uriniferous tubule is differentiated into three parts peritoneal funnel, tubule and malpighian body.

a) Peritoneal funnel - It is a funnel-like ciliated structure which open into coelom by a aperture, the nephrostome or coelomostome



Structure of an embryonic kidney. (Nephron) | Hypothetical primitive kidney

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Faci draining wastes from coelomic fluid. Nephrostome are usually confined to embryos and larval and considered vestiges of a hypothetical primitive kidney.

b) Malpighian body — A tubule begins and blind cap like, hollow double walled Bowman's capsule. It encloses, a tuft of blood capillaries, called glomerulus. Bowman's capsule and enclosed glomerulus together form a renal corpuscle or Malpighian body. Encapsulated glomeruli are termed internal glomeruli which are common. Those without a capsule and suspended freely in coelomic cavity are called external glomeruli (embryo and larva). Capsules without glomeruli are termed a glomerular, such as found in embryos, larvae and some fishes.

c) Tubule — All the tubular of embryonic kidney are convoluted duct that conduct the final filtrate to a longitudinal Wolffian^{duct}, which opens behind into embryonic cloaca.

Origin and evolution of kidney.

Archinephros is the name given the hypothetical primitive kidney of ancestral vertebrate. It is extend the entire length of coelom. Its tubules were segmentally arranged one nephros for each body segment.

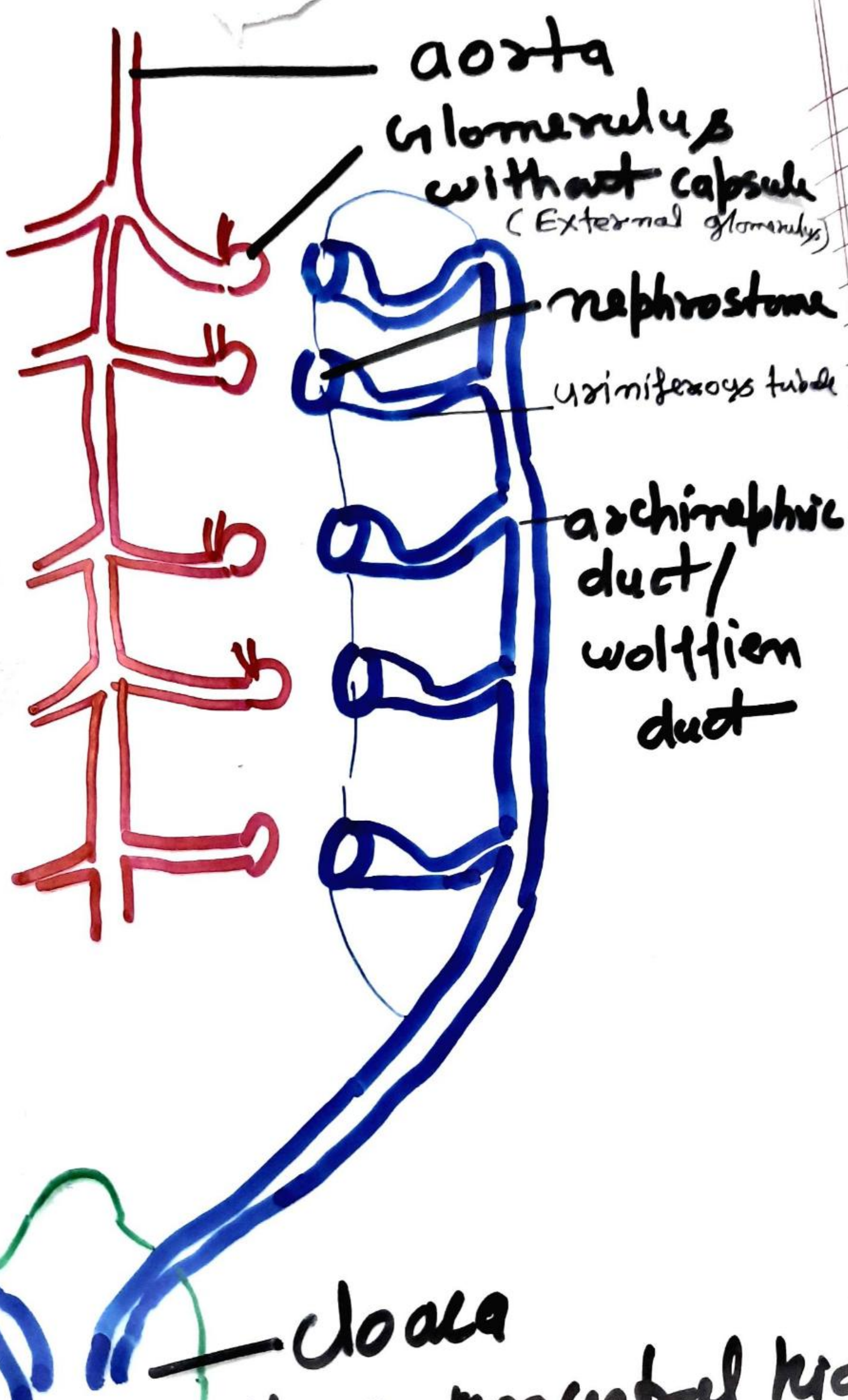
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Each tubule opens by a nephrostome into coelom. Near each nephrostome was suspended in coelom an external glomerulus (without capsule). All the tubules were drained by a common longitudinal wavy canal or archinephric duct opening behind into cloaca.

Hypothetical archinephros is supposed to have given rise to all the kidneys of later vertebrates during the course of evolution. Modern vertebrates exhibit three different kinds of adult kidneys; pronephros, mesonephros and metanephros. It is supposed that these represent the sequence or their successive stages of development of the ancestral archinephros.

The development of the kidney tubules is a highly interesting process. The tubular development from the cephalic end backwards in a series. The anterior most ones, which develop behind the aortic region, constitute a definite embryonic kidney called the pronephros. Behind the pronephros - either immediately behind the last uriferous tubule of pronephros or with a gap of a few segments, arises another kidney, the mesonephros. Posterior to the mesonephros develops yet another set of nephridia or kidney tubules, constituting metanephros.

The pronephric tubules develop during ontogeny in all vertebrates, but only in a few are they functional, in the larval state.



hypothetical primitive central kidney
or Archimephros

The pronephros is not the functional kidney of the adult in any vertebrate, and is replaced by another kidney the functional one, as the embryonic life comes to an end the mesonephros is the kidney of fishes and amphibia, where as in Amniota the functional kidney in adult stage is metanephros. The mesonephros and its duct give rise in Amniota to certain accessory organs of the reproductive system, but have no renal function in the adult.

Pronephros, mesonephros and metanephros may now be separately considered.

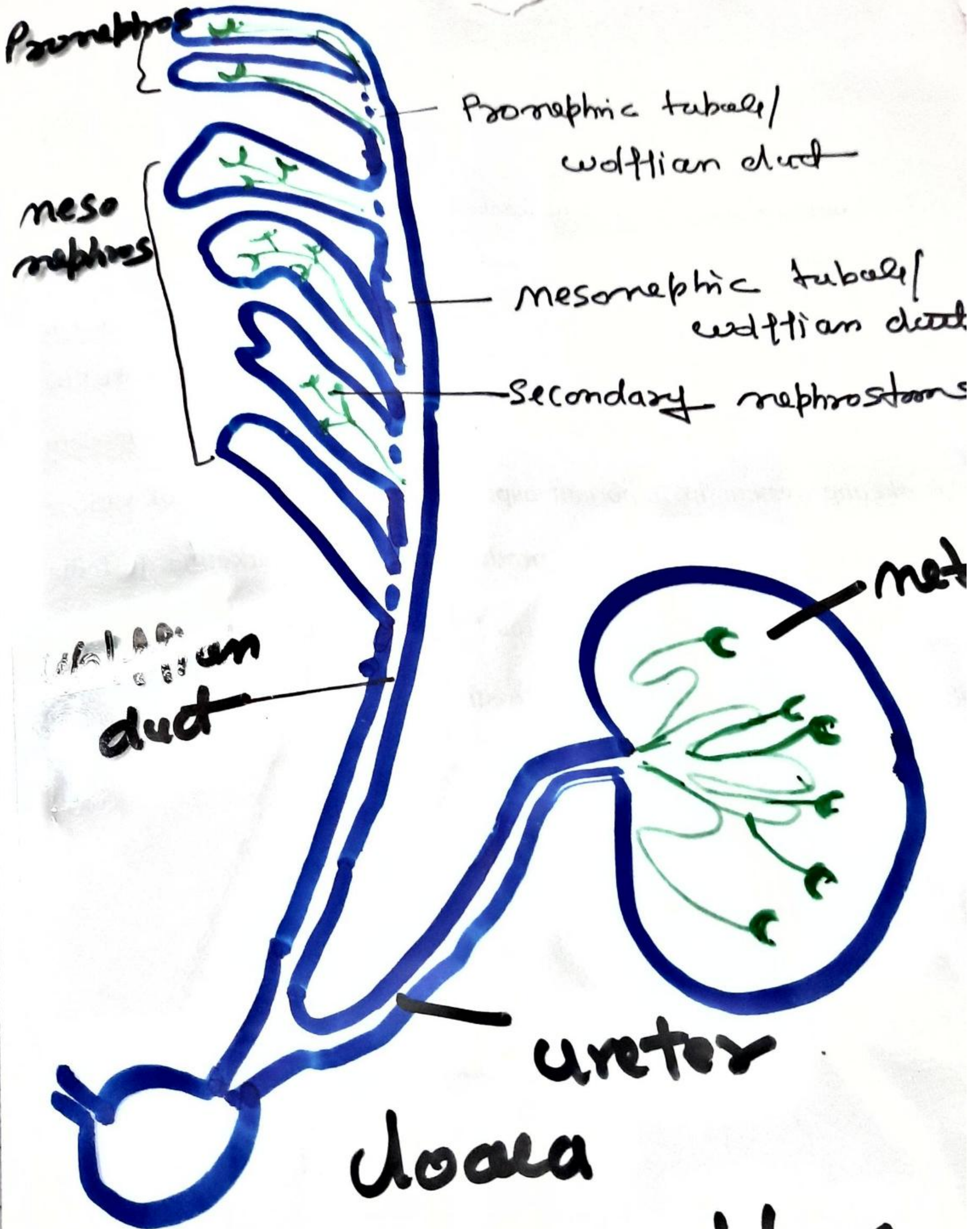
Pronephros - In the embryo of all vertebrates the first kidney tubules appear dorsal to the anterior end of coelom, on either side. Pronephros is also termed head kidney due to its anterior position immediately behind the head. A pronephros consists of 3 to 15 tubular segmentally arising. Each tubule opens into coelom by a funnel or nephrostome. Also projecting into coelom near each tubule and not connected with its external are naked glomerules without capsule. In some cases, glomerules, called glomeruli ~~centre~~ to form a single compound glomerulus called glomerulus. Glomerulus and tubules bear

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Em-capsulated pronephric kidney
of frog larva



Plan of pro-nephros,
and metanephros in

surrounded by a large peronephric chamber
desired from pericardial or pleuroperitoneal
cavity. originally each tubule has its individual
external aperture but secondarily all tubules
of a pronephros open into a common peronephric
duct, posteriorly into the embryonic cloaca.

Embryonic development - Pronephric tubules develop
as tubular diverticula from
the nephrostome towards the ectoderm. It is the
somatic wall of the nephrostome that is drawn
out to form this tubular outgrowth. Such out-
growths arise from the nephrostomes over a
number of successive segments on both sides.
There are the pronephric tubules. Towards the
outer side these tips bend backwards, meet each
other, and fuse to form a solid cord of cells
which grows backwards and later on, becomes
canaled to produce the longitudinal pronephric duct.
Into the pronephric duct thus open the successive
pronephric tubules.

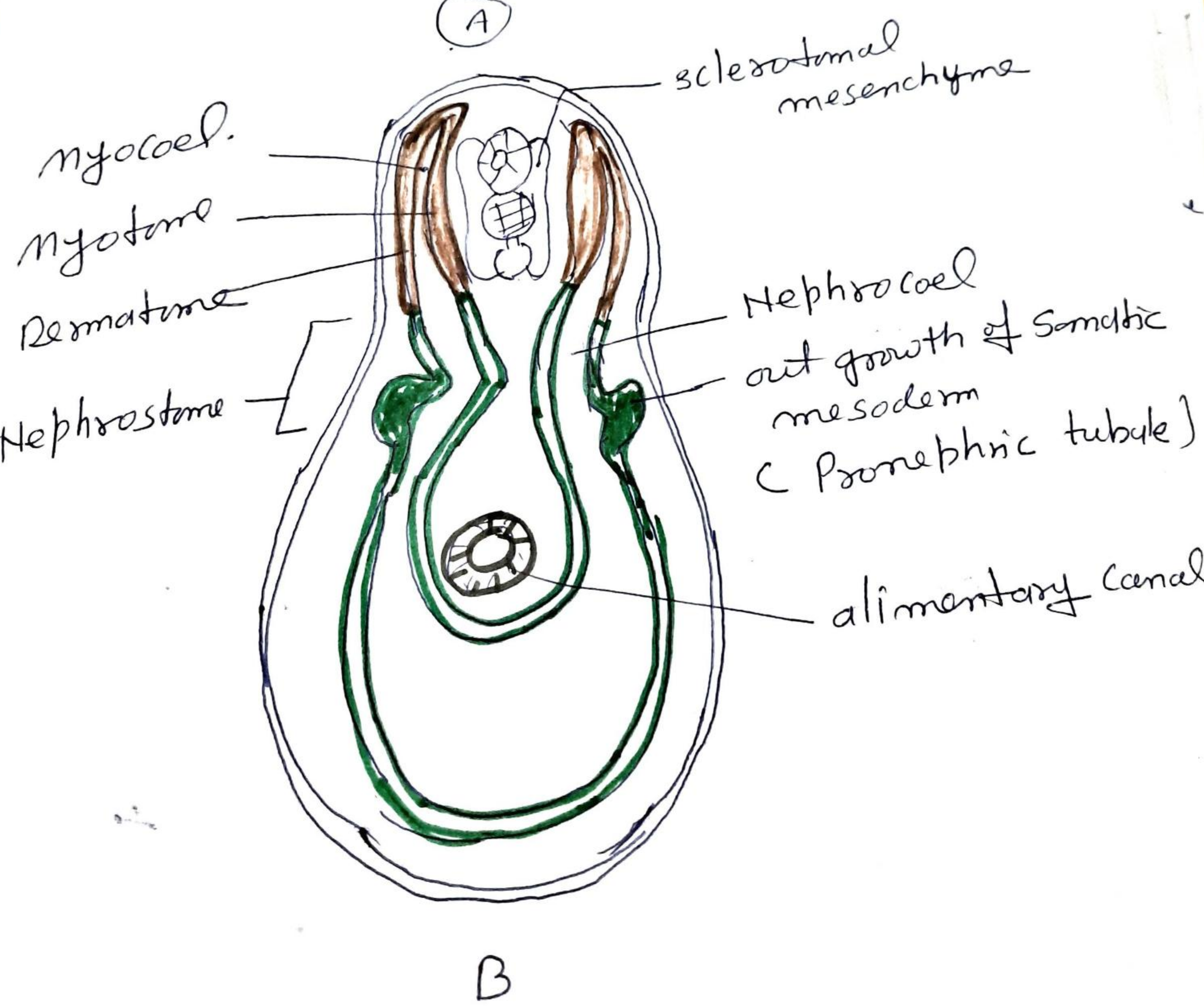
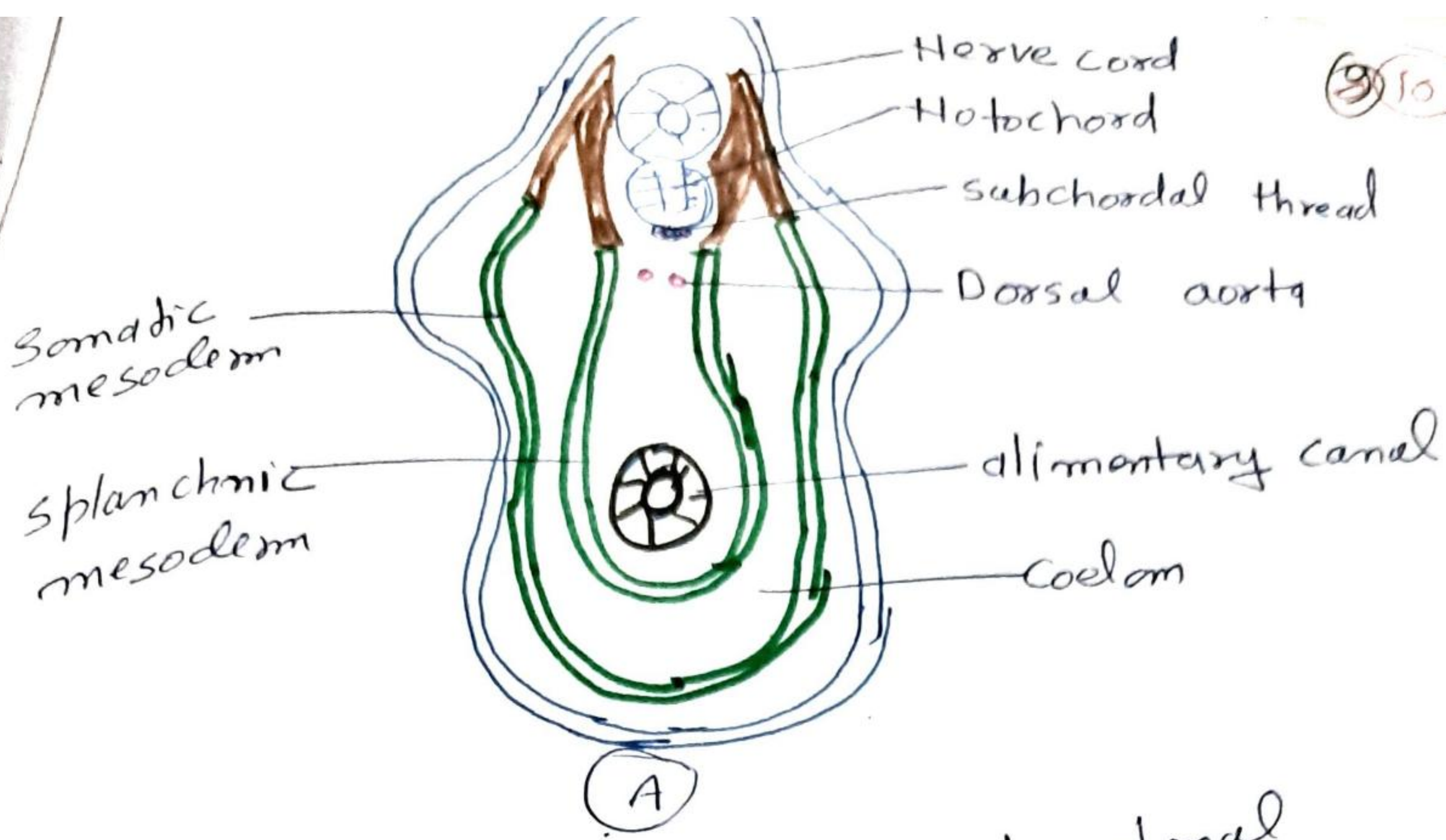
The first pronephric tubules arise
in some of the anterior trunk segment behind
the ear region. The next exact position above
the first tubule vary in the various classes of
vertebrates.

When the pronephric tubules begin to
arise, the nephrocoelic chamber (cavity of nephrostome)

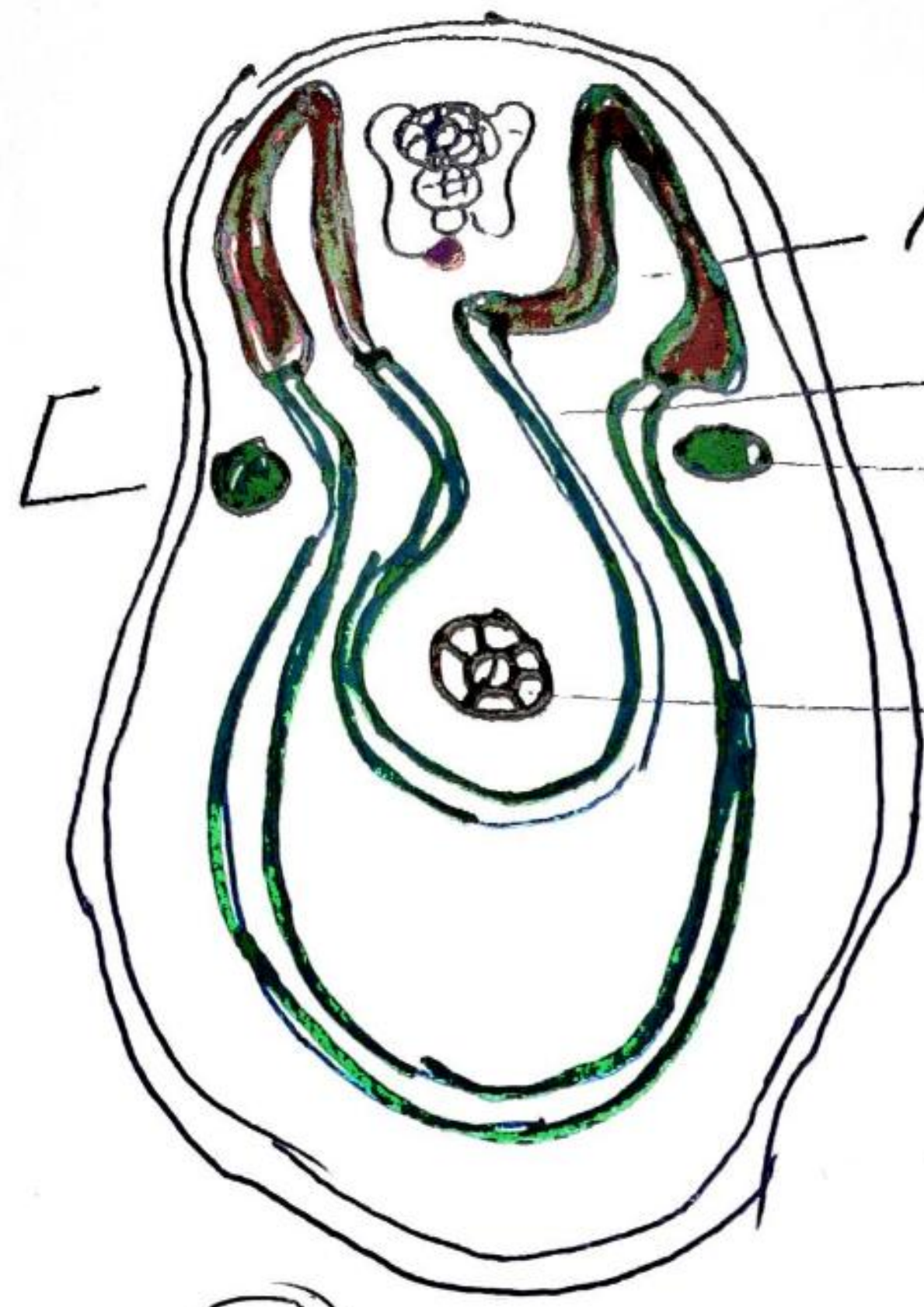
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Nephrostome



Nephrocoel

Nephrocoel

Pronephric duct

alimentary canal

(c)

Dermatome

Myotome

sclerotomal mesenchyme

lateral plate mesenchyme



nerve cord

notochord

dorsal aorta

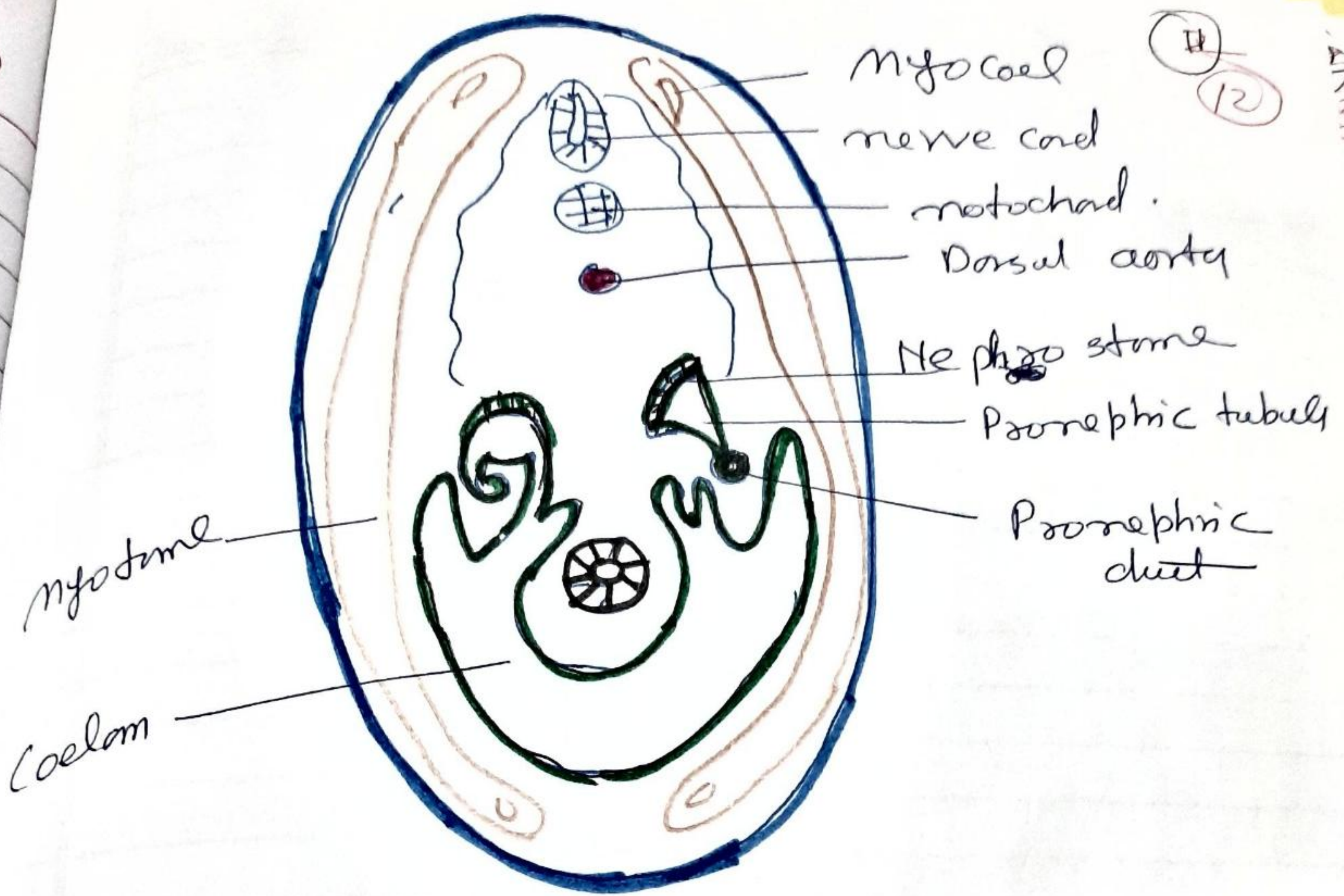
myocoeel

Nephrostome

Pronephric

Coelom

(d)



Transverse section of Gnathostome embryos showing progressive stage in development of pronephric tubule, nephrostome and pronephric duct.

is cavity an exceedingly small size, much like a yissure. As the pronephric tubules develop it swells up into a thin-walled, bladder-like structure. The nephrocoel open into the myocoel on the one hand and the coelom on the other. When the pronephric tubule is formed the nephrostome becomes completely cut off from the myotomal nephrocoelic chamber above. The opening of the nephrocoelic chamber into the coelom (the cavity giving rise to the peritoneal canal and peritoneal funnel).

A branch from the dorsal aorta capillarizes on the ~~the~~ visceral wall of the nephrostome which is pushed into the nephrocoel. Blood from the capillary network is gathered back into a vein, which open into the posterior cardinal vein. Thus arises the glomerulus.

The pronephros in different classes of vertebrates

Elasmobranchii — There are 1 to 4 pronephros in the shark, *Pristiurus*, but any three of these gave rise to the rudiments of pronephric tubules. Glomeruli and Bowman's capsules are not formed and the entire pronephros

which is never functional, degenerates away completely. (13)

Polypterygium — In polypterygium rudiments of pronephric tubules arise in 7 or 9 segment but, only two remain functional (14)

These are only 3 pronephric tubules in frog embryo, 7 in human embryo and about a dozen in chick embryo.

Mesonephros

mesonephric tubules arise from nephrostom in the same way as pronephric tubules i.e. as tubular out growth commonly develop at a later period than the pronephros and are formed behind the last pronephric tubule.

When the mesonephric tubules are formed, their outer tips come into contact with the wall of pronephric duct, which has already arisen. The tips get fused with the wall and openings arise at the points of fusion so that successive mesonephric duct in the zone of the mesonephros. Therefore called the mesonephric duct or the wolffian duct.

During development the entire nephrostome is not used up in forming the primary mesonephric tubule. A part of the nephrostome remaining portion of the primary nephrostome a part is now split off, forming the secondary a part is now split off, forming the secondary nephrostome. This give rise to the secondary mesonephric tubule in the usual way. From the secondary mesonephric tubule of successive generation open into the collecting tubule of the primary mesonephric tubule, which, of course open into the Wolffian duct.

Mesonephros functionally better than pronephros because mesonephric tubules are more numerous, longer and develop internal glomeruli enclosed in capsules forming malpighian bodies thus, they remove liquid wastes directly from glomerular blood rather than indirectly from coelomic fluid as in case of a pronephros. The mesonephros is also called Wolffian body with disappearance of the pronephros, the old pronephric duct becomes the Wolffian or mesonephric duct.

Some of the anterior (tubules of pronephros) become a part of genital system, serving to carry the sperm. while in female corresponding part of pronephros become degenerated. The mesonephric duct of male carry sperm as well as urine, Thus serves as urinogenital duct.

In female an addition Mullerian duct arise which carry ova. released by ovary. Mullerian duct are vestigial in male.

origin of Mullerian duct - in two different ways.

In Elasmobranchs and tailed amphibia.

The archinephric duct divides longitudinally into two, one of these remains in the series of kidney as a archinephric duct proper the other become the mullerian duct.

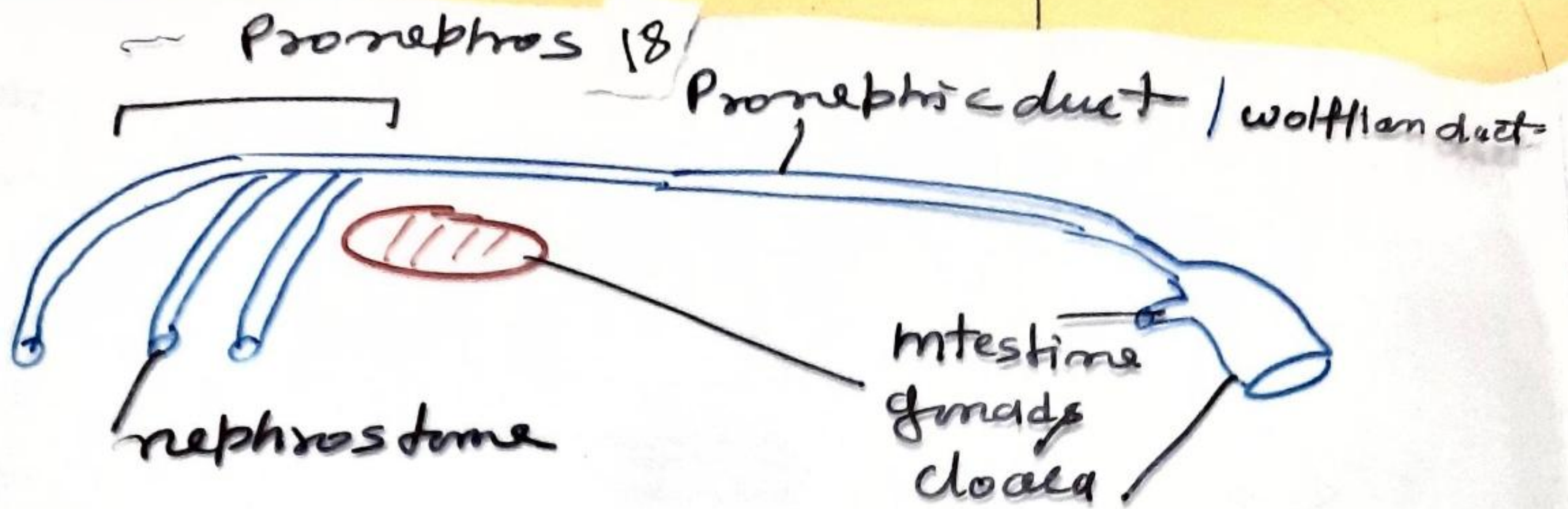
Mullerian duct becomes connected to one or more pronephric tube. The funnels (nephrostome) of the tubules persist in adult to form the oviducal funnel and the ostium Mullerian duct open into urinogenital sinus of cloaca.

3. In other anamniota (and amniota).

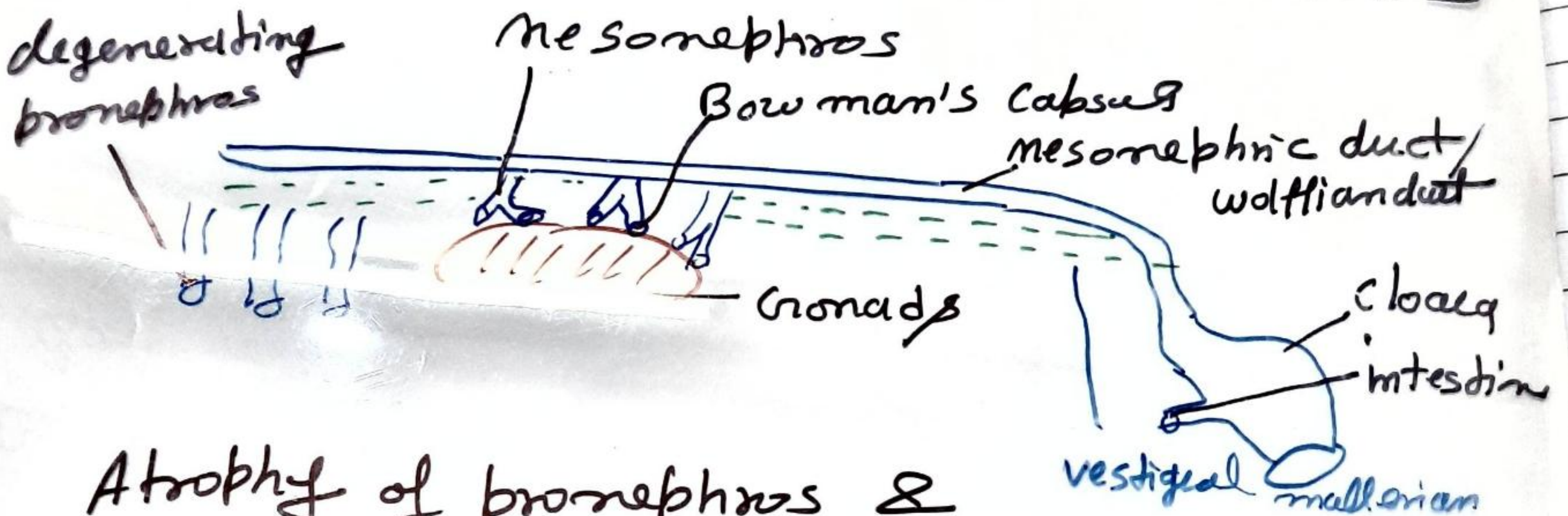
The Mullerian ducts arise independently from grooves or invagination of peritoneum covering, the ventrolateral part of mesonephros near its anterior end.

The edges of grooves meet, covering the grooves into tube, which grow back to open into cloaca.

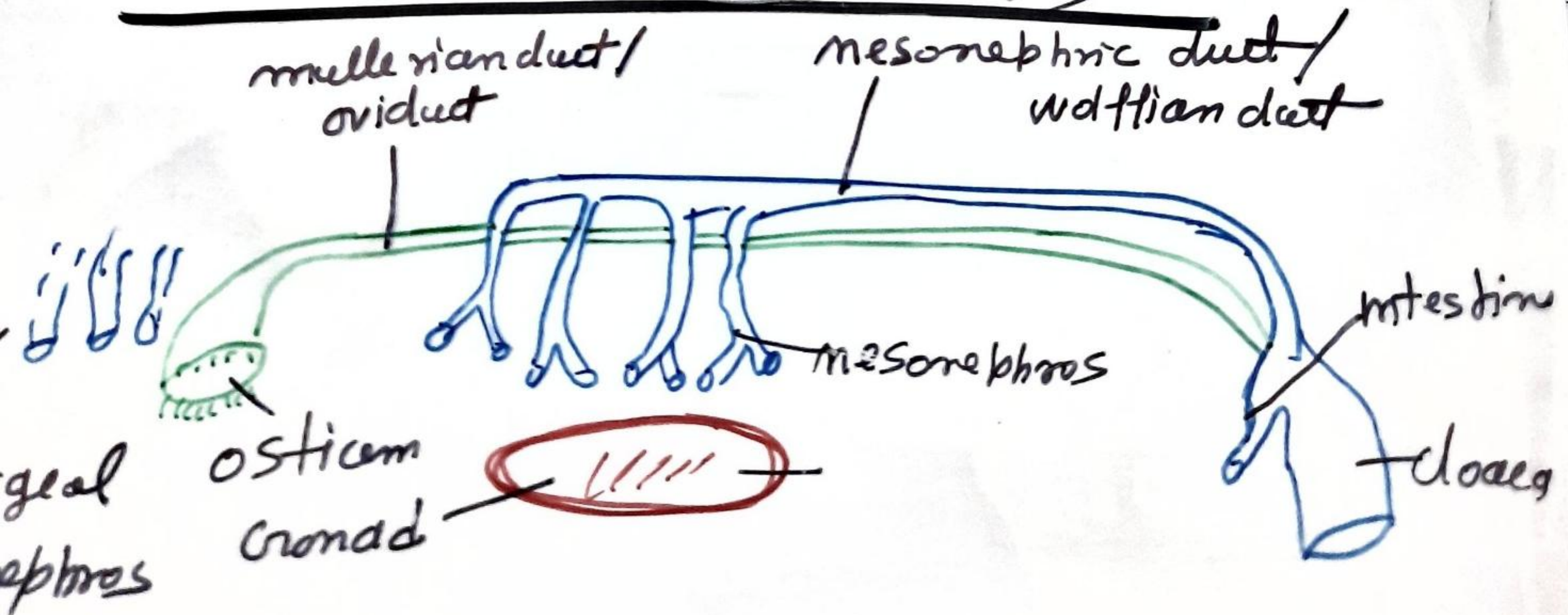
The anterior ends of tubes remain widely open as ciliated asexual funnels.



Development of pronephros (Embryonic Vertebrate)



Atrophy of pronephros & development of mesonephros (Embryonic Anamniotes and amniotes)



Female Anamniotes