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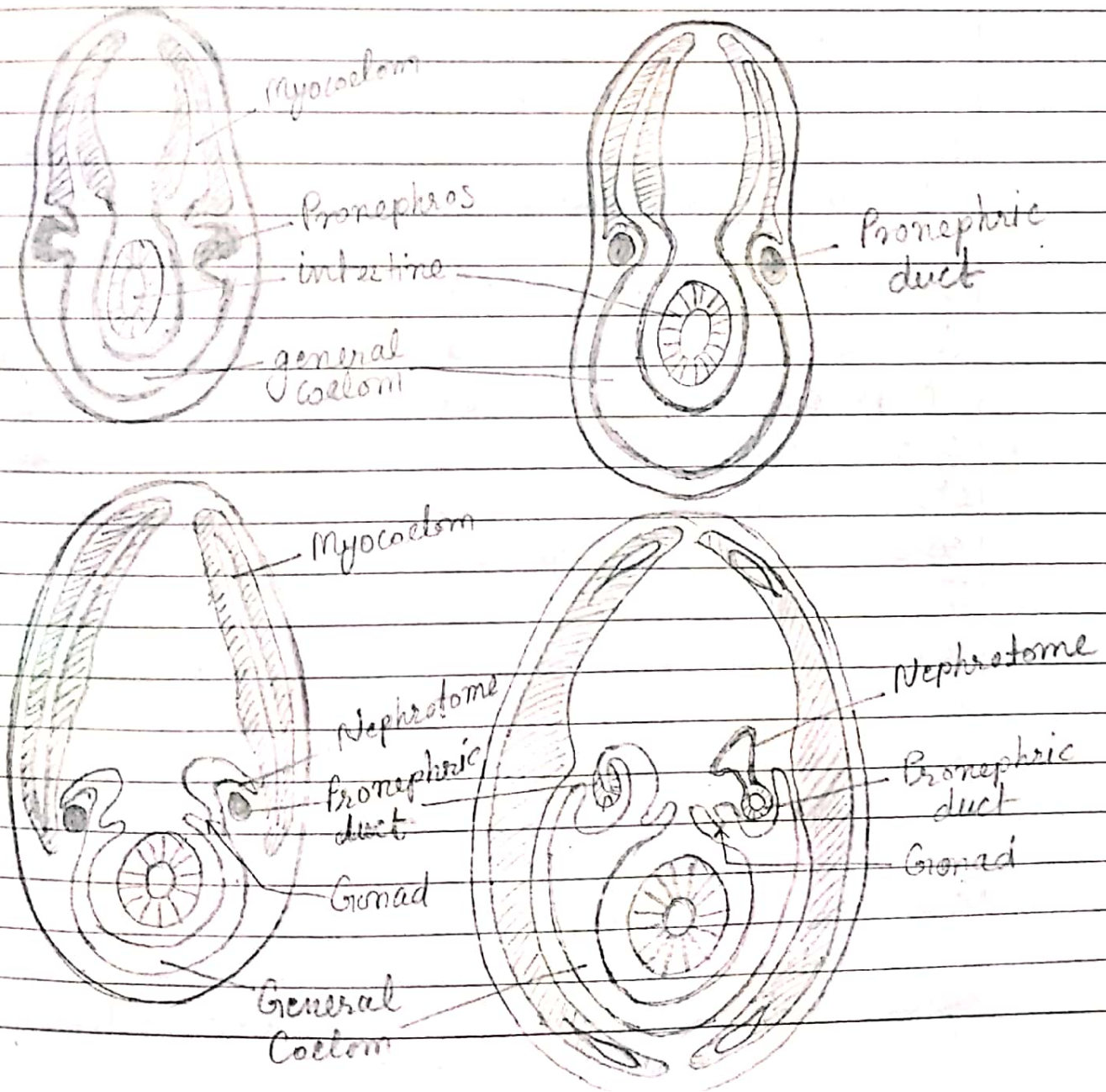
Evolution and Fate of kidney in Vertebrates

Urinary and genetic organs of vertebrates arise from mesoderm and are closely connected genetically, morphologically and physiologically. kidney takes its final form through a series of ontogenetic stages in which series of organs replaces each other and may physiologically combine with the genetic organ. These ontogenetic stages of kidney development are (1) Fore-kidney or Pronephros (2) mid kidney or mesonephros and (3) hind-kidney or metanephros



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→ In all true fishes and amphibians, pronephros is provisionally formed and mesonephros is permanent
→ In Amniota both pronephros and mesonephros are provisionally formed and metanephros is permanent.

Pronephros

Rudiments of the pronephros is present in the anterior segment of the trunk of the organism

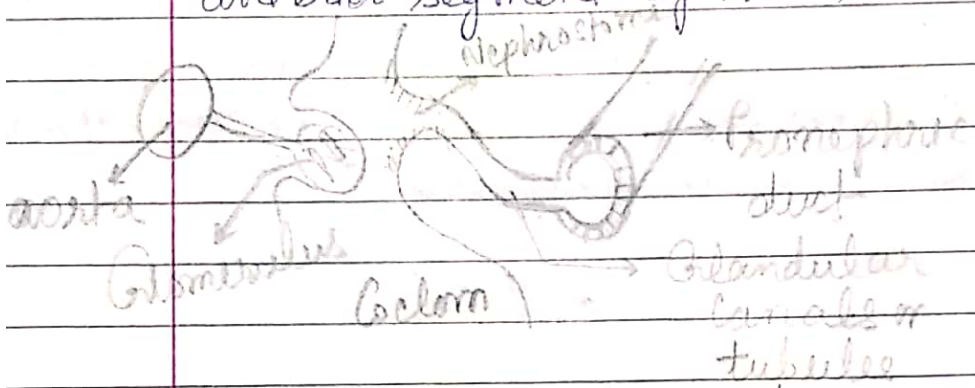

Fig - Formation of pronephros and glomerulus

Pronephric or Archinephric duct runs laterally passes backwards to open into the cloaca.

Glandular canals/tubules runs transversely and connects to pronephric duct on one side and to body coelom by means of a ciliated funnel-shaped aperture (Nephrostome) on the other side. The inner wall of the coelom projects towards each canal into which capillary branches from aorta extends and forms Glomerulus.

In Myxinoids the pronephric rudiment extends along almost the whole length of the coelom but in other vertebrates (eg Elasmobranchii & Amniota) it is more or less shortened and consists of only a small no. of canals. So it is probable that pronephros at one time extended further back possibly along the whole length of the trunk and then became reduced owing to the develop. of another set of urinary tubules — mesonephros

Mesonephros

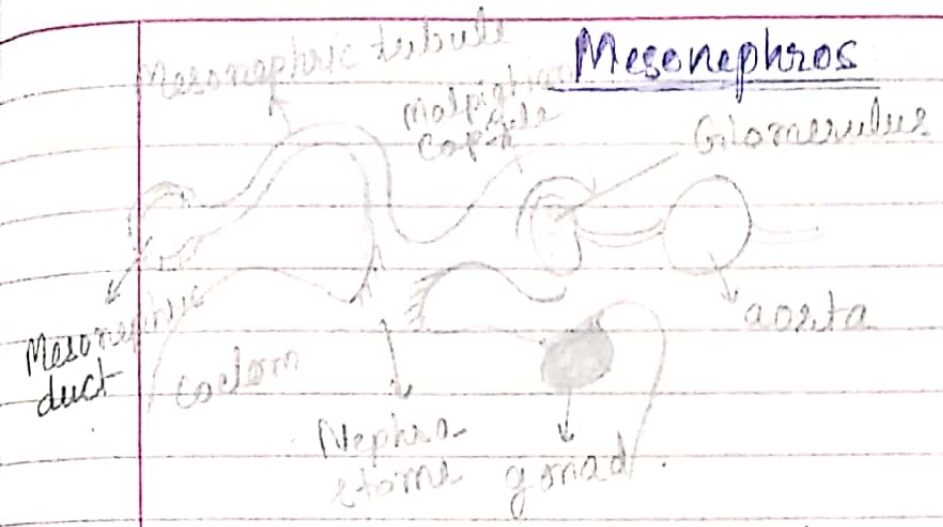

Fig : T.S developing mesonephros

Mesonephros or Wolffian body is originally strictly segmental i.e its tubules corresponds with part of the mesoderm called nephrotomes, which later become separated from somites but retain their connection with coelom into which each of them open by a ciliated nephrostome, the other end being connected with the pronephric duct which now serves as a mesonephric duct. The tubule now increases in length and become S shaped and differentiated into several portions. the middle one expanding to form a vescicle (Bowman's capsule) into which a tuft of capillaries is (glomerulus) is formed by a branch of aorta. The whole constitutes a Malpighian capsule. The further development of the mesonephros varies greatly in diff. vertebrates like in many fishes it serves exclusively as a urinary organ but in higher forms it takes on relation with the gonads giving rise to rete and vasa efferentia of the testes as well as part of the epididymis. In Amniota it forms more or less vestigial organs of secondary importance (parovarium, hydatid of Morgagni, paradidymis). In Elasmobranchs & amphibians, it serves as permanent urinary organ. In Amniotes, it almost entirely disappears and a third series of tubules develops giving rise to metanephros.

Metanephros

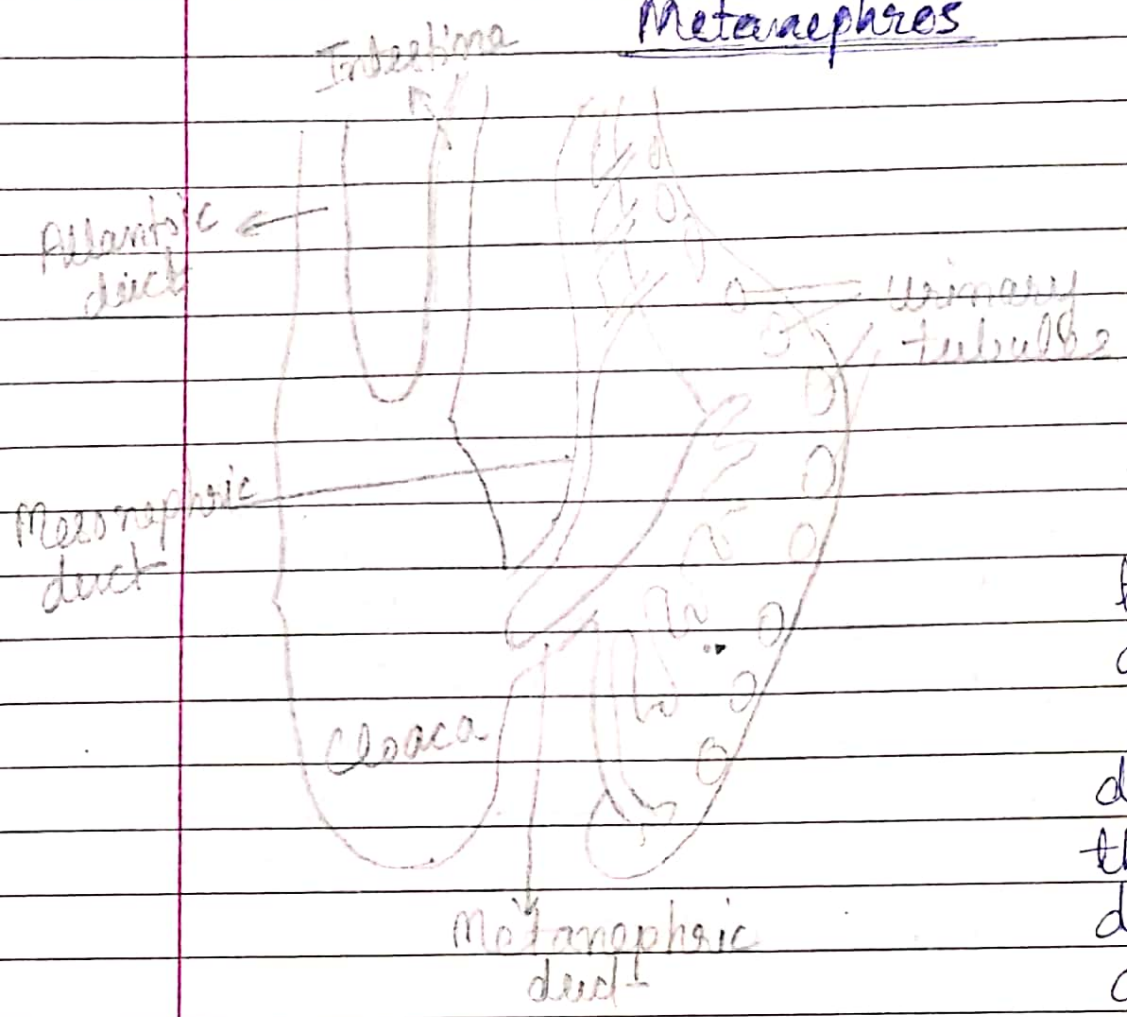

Fig : Relations between Meso and metanephros

All tubules and glomeruli arise from nephrogenetic blastema. The straight collecting portion of the metanephric tubules originate as outgrowth from mesonephric duct - as do also the metanephric duct - (ureter) and in mammal the pelvis of the kidney. So in Amniota metanephros corresponds to a well developed and specialised posterior portion of the mesonephros. Nephrostomes are absent. The posterior end of the ureter loses its connection with the mesonephric duct and opens independently either into the cloaca or into urinary bladder.