# VIVEKANANDA COLLEGE

**THAKURPUKUR**

**KOLKATA-700063**

**NAAC ACCREDITED 'A' GRADE**

**Topic:** URINOGENITAL SYSTEM

**Course Title:** COMPARATIVE ANATOMY OF VERTEBRATES

**Paper:** CC8 (ZOOA-CC4-8-TH)

**Unit:** 5

**Semester:** 4TH

**Name of the Teacher: Dr. Shaoli Majumder**

**Name of the Department: Zoology**

# THE KIDNEY OF VERTEBRATES

- a pair of compact kidneys
- dorsal to the coelom in trunk region, one on either side of vertebral column
- made of a large number of uriniferous tubules or nephrons
- their number, complexity and arrangement is different in different groups of vertebrates

Dr. Shaali Manjander

A uriniferous tubule has the following parts:

(i) A ciliated peritoneal funnel or nephrostome near the proximal end of the tubule.

(ii) A convoluted ciliated tubule opening into a longitudinal collecting duct, and a Malpighian body or renal corpuscle.

The Malpighian body has a double-walled Bowman's capsule, enclosing a network of inter-arterial blood capillaries, called glomerulus where filtration of blood takes place.

An afferent arteriole brings blood into the glomerulus and an efferent arteriole takes blood away from it.

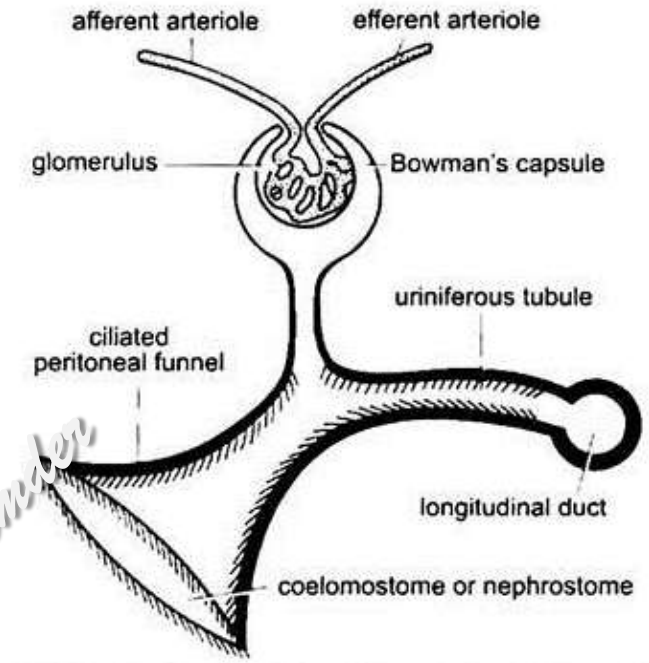



Fig. 48.1. Structure of an embryonic kidney tubule.

Dr. Shaili Mahajan

# Embryological origin:

•originated from the intermediate mesoderm or nephrogenic mesoderm

•at the onset of its differentiation, posterior region of the intermediate mesoderm expands forming a nephric ridge

•next structure to appear is segmental paired nephrotome which contains the nephrocoel, a coelomic chamber that may open via a ciliated peritoneal funnel to the coelom.

•next, medial end of the nephrotome widens into a thin-walled renal capsule into which grows the glomerulus, a tuft of arterial capillaries

•lateral end of the nephrotome grows outward which fuses with similar outgrowths from successive nephrotomes to form the common nephric duct

•the modified nephrotome is more properly called a uriniferous tubule to now include the nephric duct, plus its connection by the nephric tubule to the nephrocoel, which may or may not retain a connection with the coelom via a persistent peritoneal funnel.

Dr. Shadi Mostafa

# •Succession of Kidney

•The development of the kidney is somewhat complex in that two or three different kidneys (depending on species) formed in temporal and spatial sequence.

•The first, most anterior and largest to develop is the pronenphric kidney.

•The second kidney to form is the mesonephric kidney.

•In birds, reptiles and mammals, a third kidney developed posterior to the mesonephros, called the metanephric kidney.

•The evolution of the kidney in vertebrates illustrates how pronephric, mesonephric and metanephric kidney, represent successful evolutionary responses to the changing environmental pressures of fresh water, marine and terrestrial habitats.

Dr. Shashi Manhas

# Archinephros:

kidneys in all modern vertebrates evolved from a hypothetical kidney known as Archinephros or Holonephros, which extended from anterior to the posterior end of the body.

consisted of a pair of archinephric ducts located on the dorsal side of the body cavity and a series of segmentally arranged tubules; one pair per body segment.

Each tubule opened separately into the coelom by a ciliated, funnelshaped, peritoneal opening called the nephrostome.

Near each funnel was an external glomerulus (without capsule), suspended in coelom and located in close proximity to the nephrostome.

The English embryologist Balfour suggested that the three types of kidneys found in modern vertebrates, namely, Pronephros, Mesonephros and Metanephros evolved from the anterior, milddle and posterior regions of this archinephros.

Dr. Shaili Malhotra

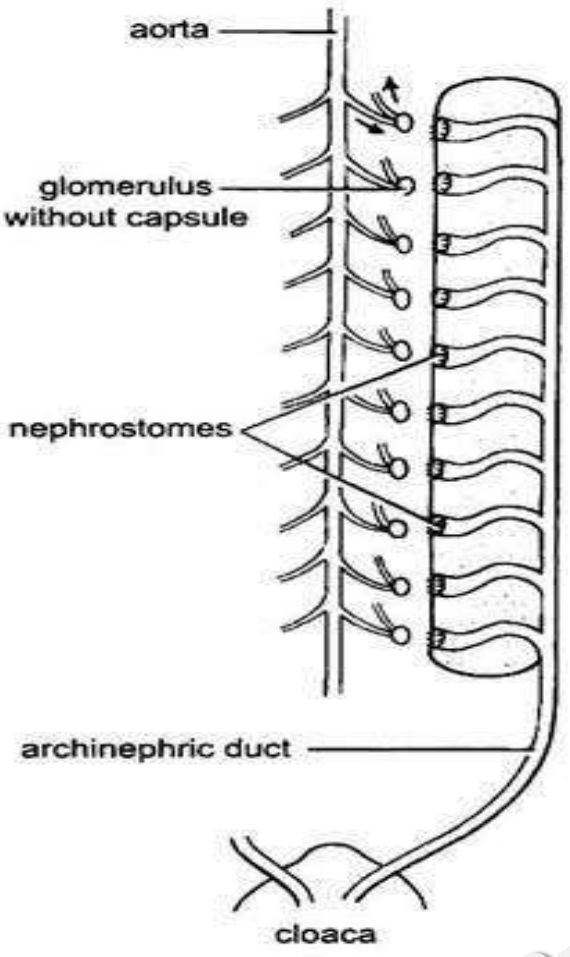



Fig. 48.2. Primitive ancestral vertebrate kidney or archinephros.

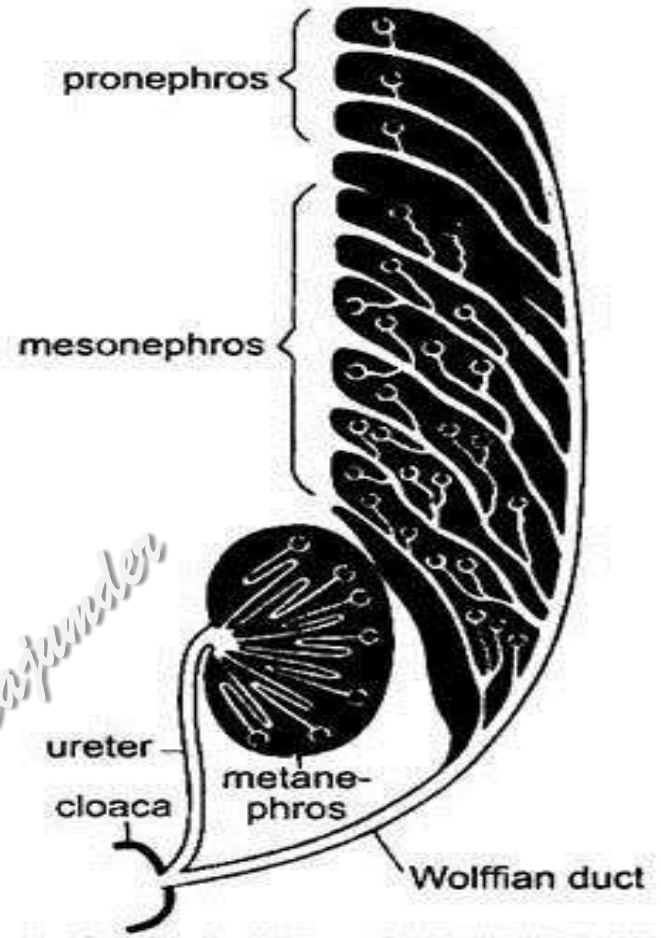



Fig. 48.4. A plan of pronephros, mesonephros, and metanephros.

Dr. Shaoli Majumder

# Tripartite Concept of Kidney Organization

Nephric tubules may arise within the anterior, middle, or posterior region of the nephric ridge, giving rise to a pronephros, mesonephros, or metanephros, respectively.

Subsequent loss, merger, or replacement of these tubules constitutes the developmental basis for the definitive adult kidneys. In addition to positional differences, the three regions vary with respect to connections to the coelom. In the pronephros, tubules usually retain their connections to the coelom through the peritoneal funnel; however, tubules arising within the middle or posterior regions lose this connection in adult vertebrates.

Thus, in present vertebrates, kidneys are of three types and all three are fundamentally alike, differing principally in their relationship to the blood system, in degree of complexity, and in efficiency.

However, anatomical demarcations between these three regions of the nephric ridge are not always apparent, and the three types of kidneys arise as parts of one organ, the holonephros, which produces tubules in anterior to posterior succession during development. Thus, the holonephros is that part of the nephric ridge that produces the kidney.

Dr. Shadi Mahamid

# 1. Pronephros:

•only a transient embryonic developmental stage in all vertebrates.

•has very few (3-15) uriniferous tubules that appear within the anterior part of the nephric ridge and are called pronephric tubules.

•These tubules join to form a common pronephric duct which grows posteriorly in nephric ridge and open into the cloaca.

•Glomeruli may protrude into the roof of the body coelom, and fluid filters across epithelial membranes and from them into the body cavity. Pronephric tubules then take up this coelomic fluid through ciliated peritoneal funnels, and eventually excrete the fluid as urine.

•functional kidneys in larval cyclostomes, some primitive adult teleost fishes, and embryos of most of the lower vertebrates. In most vertebrates, the embryonic pronephros regresses and is replaced by a second type of embryonic kidney, the mesonephros.

Dr. Shaik Mazhar

# 2. Mesonephros:

•arises in the middle of nephric ridge with the disappearance of pronephros.

•number of uriniferous tubules increases to thousands and glomeruli are enclosed in a cup-like Bowman's capsule; the latter two together are called Renal corpuscle or malpighian body.

•In addition, there is also a nephrostome attached to the collecting tubule.

•mesonephric uriniferous tubules do not produce a new duct but instead tap into the preexisting pronephric duct and is renamed as mesonephric duct.

•It is functional kidney of the larvae as well as the adults of fish and amphibian and functional kidney in the embryonic stage of amniotes, i.e. reptiles, birds and mammals.

•In some anamniotes (eg. sharks, caecilians and urodeles), mesonephros extends behind the pronephros and is functional both in embryos as well as in adults. This extended mesonephric kidney with additional posterior tubules is termed Opisthonephros.

•In amniotes, the mesonephros is replaced in later development by a third type of embryonic kidney, the metanephros.

Dr. Shalini Majumder

# 3. Metanephros:

functional kidney only in adult amniotes and have achieved the separation of the urinary function from the genital function which appears to be the trend in the evolution of the urinogenital system.

formed from the posterior-most part of the nephrotome behind the embryonic mesonephros. During embryonic life, however, both pronephros and mesonephros make their appearance.

metanephros fundamentally resembles the mesonephros, but the metanephric tubules become long and much coiled, a thin U-shaped loop of Henle is formed in between proximal and distal convolutions of the tubule, and they lack peritoneal funnels so that all connection with coelom is lost.

However, reptiles do not have loop of Henle and birds have a reduced one, both groups being uricotelic do not excrete much water any way.

Furthermore, renal tubules, instead of draining into the archinephric duct open into larger collecting tubules which ultimately lead to a new excretory duct called Metanephric duct or ureter.

number of nephrons (uriniferous tubules plus renal corpuscles) runs into millions, thereby increasing the efficiency of kidneys to extraordinary levels.

Dr. Shaista Manzoor

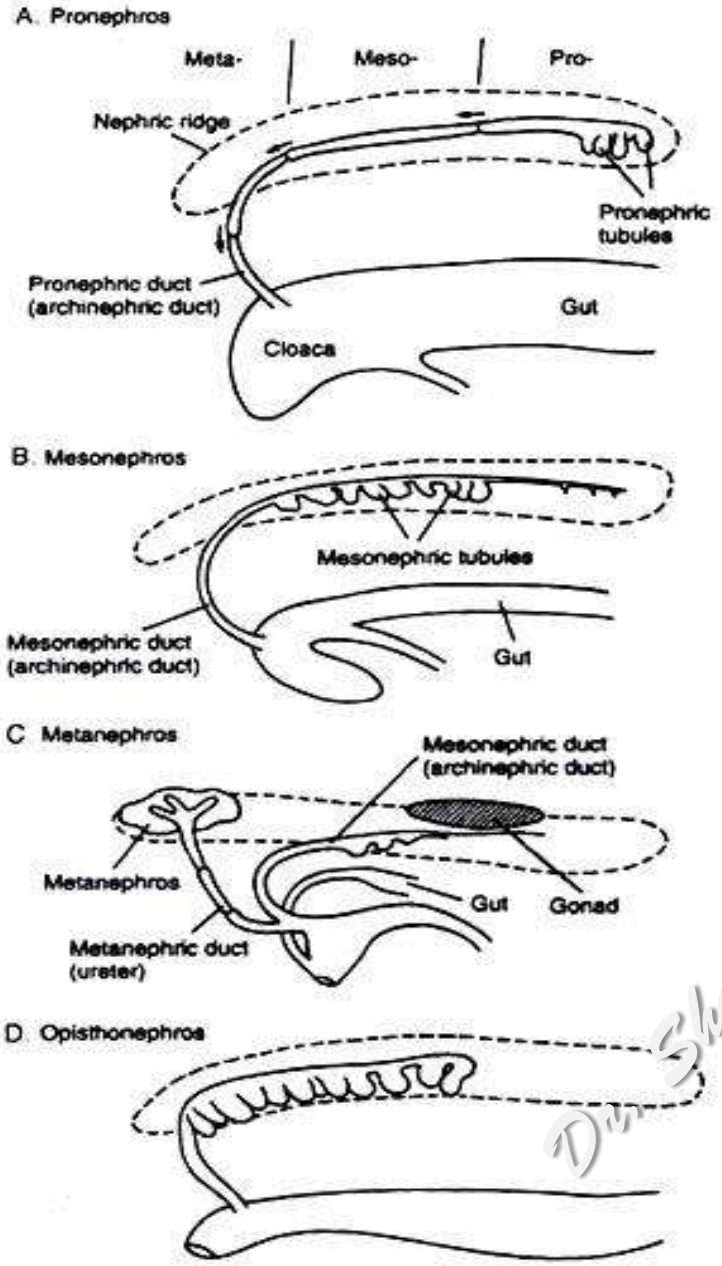



Fig. 2.49 : Embryonic origin of the kidneys. Tubules forming the kidney arise in one of three regions of the nephric ridge : anterior (pro-), middle (meso-), or posterior (meta-)

Dr. Shaali Manjunder

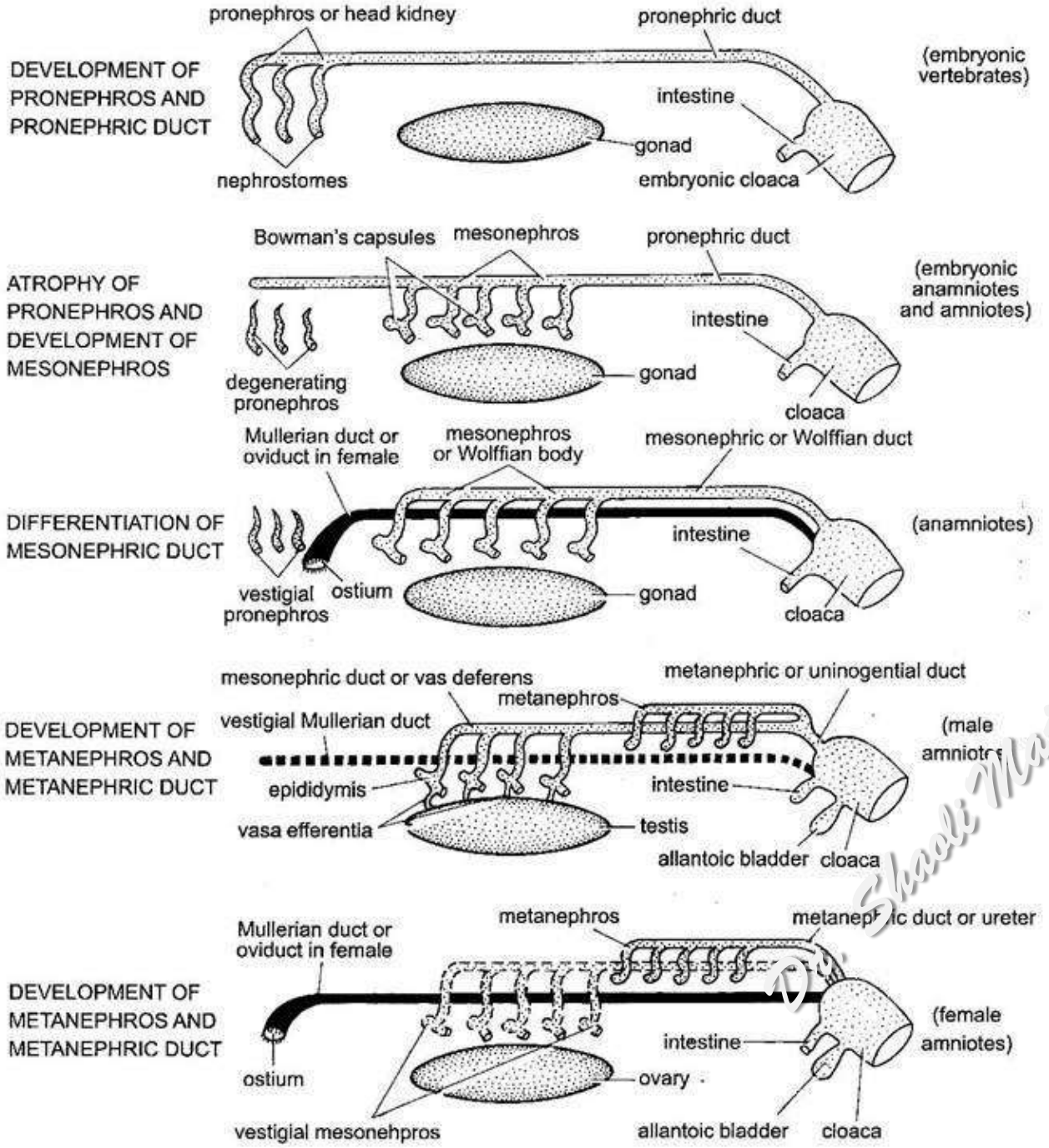



**Fig. 48.5.** Evolution of kidney in vertebrates.

Dr. Shruti Manjunder

# THE UROGENITAL DUCTS OF VERTEBRATES

In vertebrates, parts of the embryonic urinary system are salvaged by or shared with the genital system.

In the embryonic basic pattern, the kidney divides its services between reproductive and excretory roles. The function of kidney ducts is to transport urine and ducts of gonads carry either the sperms or ova.

In some species, a given duct is shared between the urinary and reproductive systems. In others, the same duct functions in only one of these systems. Even within the same species, homologous parts perform different functions in opposite sexes because of different roles they play in reproduction.

Dr. Shakti Mayurvanshi

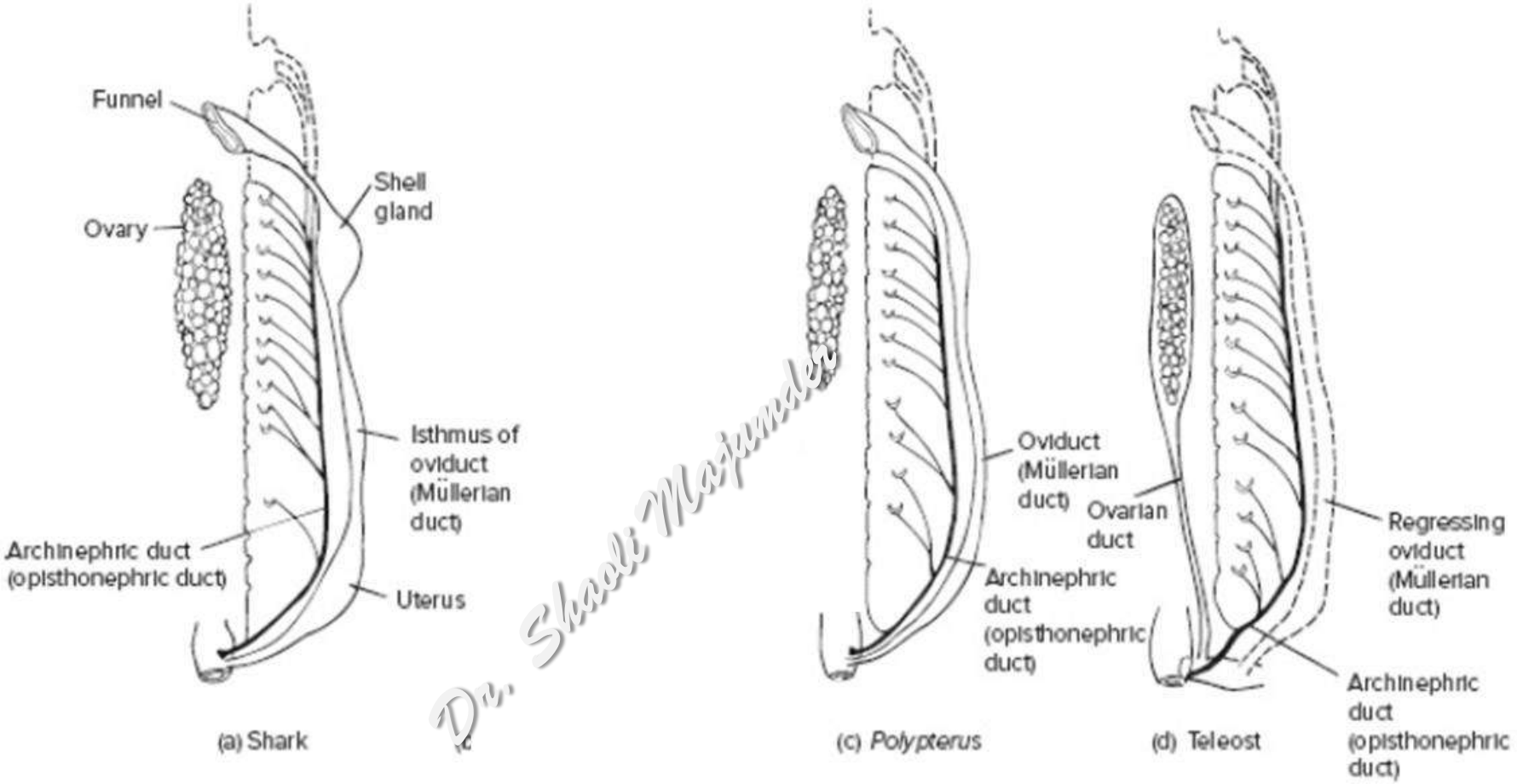
# Female Urinogenital Ducts

In anamniote females, the archinephric (mesonephric) ducts tend to function only within the urinary system. The Müllerian duct arises embryologically next to the archinephric duct and become the oviducts of the reproductive system.

In amniotic females, the mesonephric duct drains the embryonic mesonephros, but it regresses later in development when the metanephros and its ureter (metanephric duct) become the kidney of the adult. However, a second parallel Müllerian duct arises next to the embryonic mesonephric duct before it regresses and forms the oviduct, uterus, and vagina.

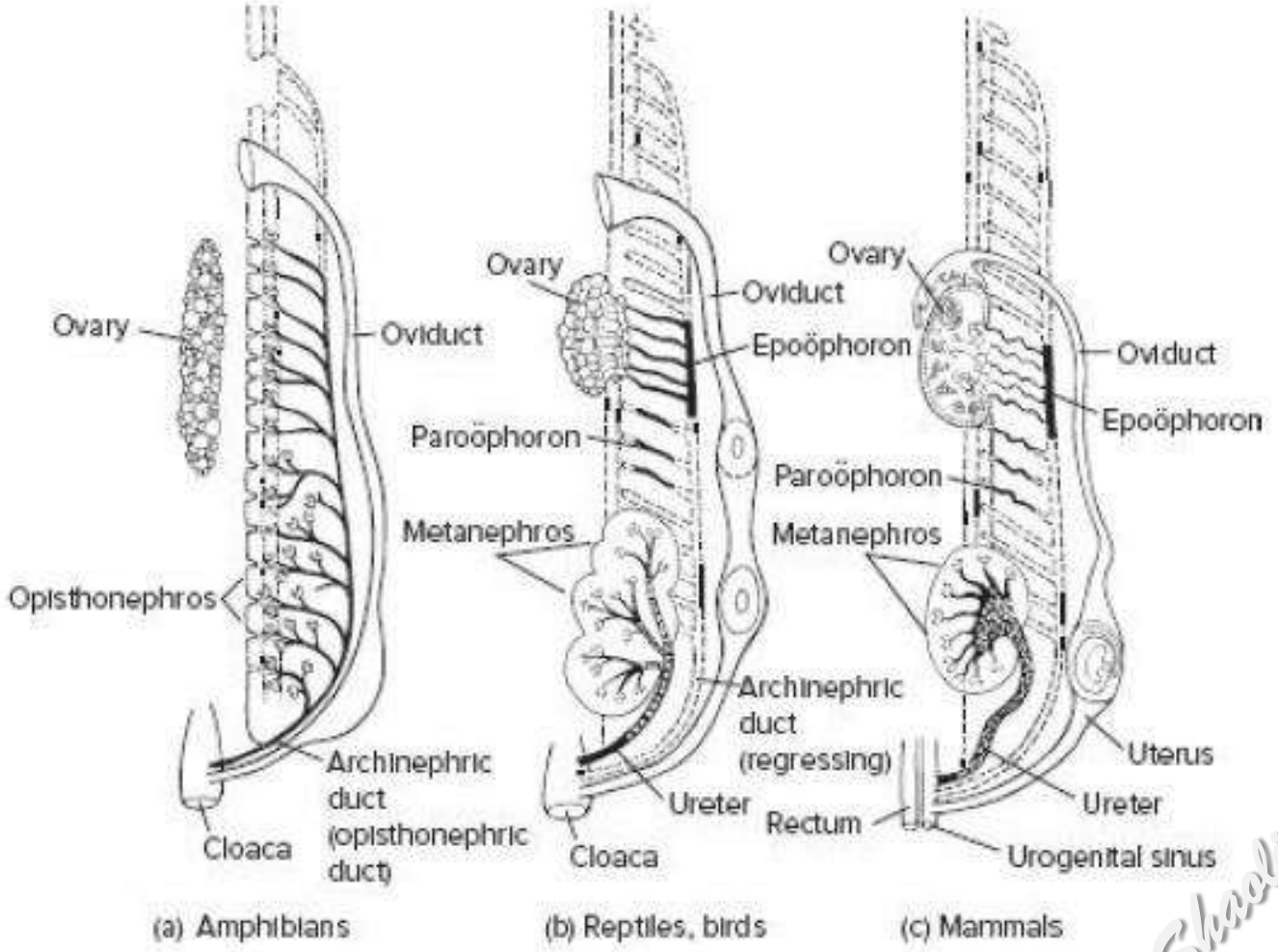
Dr. Sherif Mounir

# Fishes




Dr. Shadi Marjanedeh

# Tetrapods




Dr. Shadi Mastander

**FIGURE 14.27 Urogenital anatomy of tetrapod females.** (a) Amphibians. (b) Reptiles and birds. (c) Mammals.

# Male Urinogenital Ducts

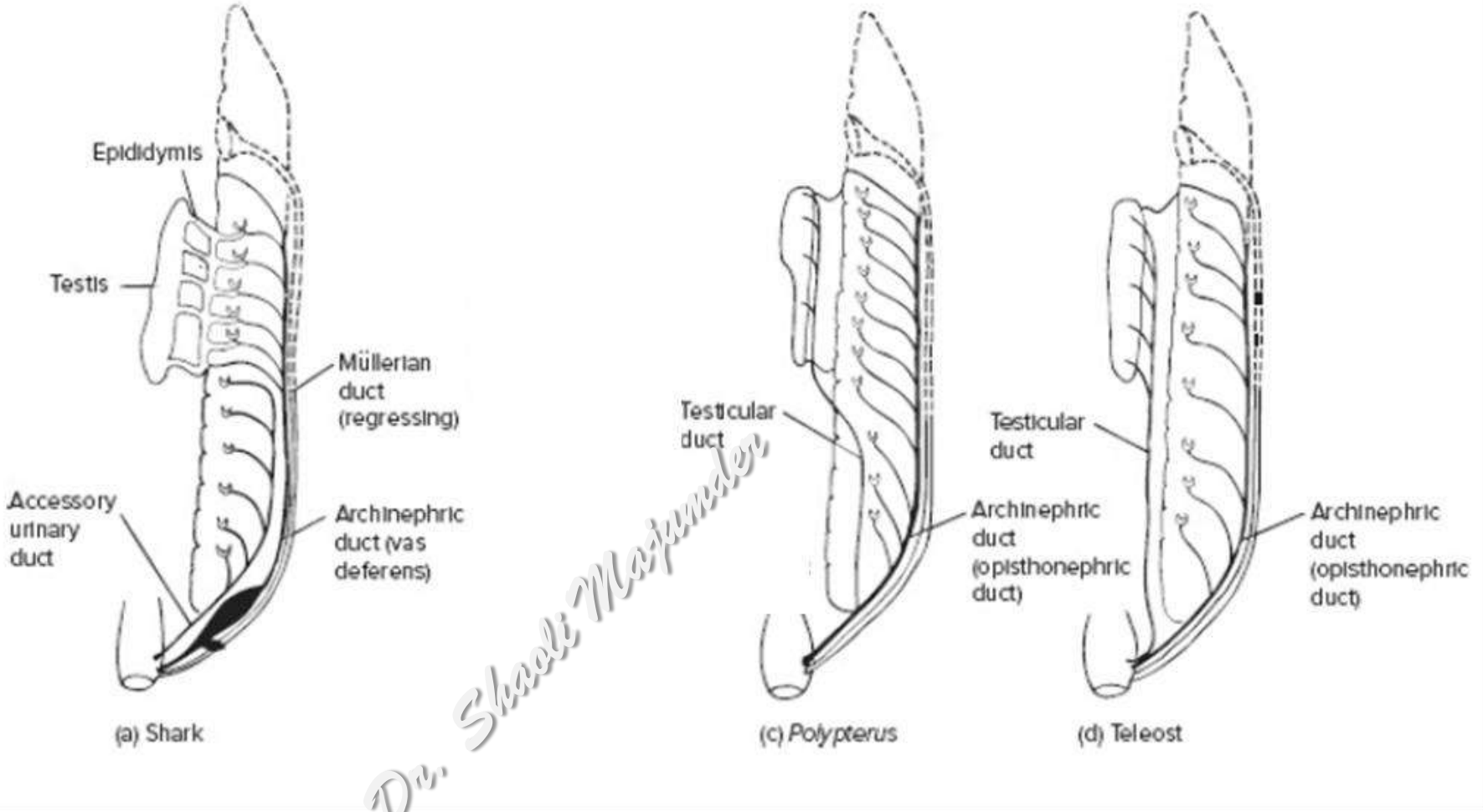
The pronephric duct usually persists and drains the mesonephros or extended opisthonephros and hence is renamed as the mesonephric duct or the opisthonephric duct, respectively.

In addition, vasa efferentia also originate by the modification of uriniferous tubules and even vas deferens is considered a modification of archinephric duct. These ducts help to transport sperm from gonad to genital opening.

With the dual role of urinary and reproductive , archinephric duct now renamed as Wolffian duct.

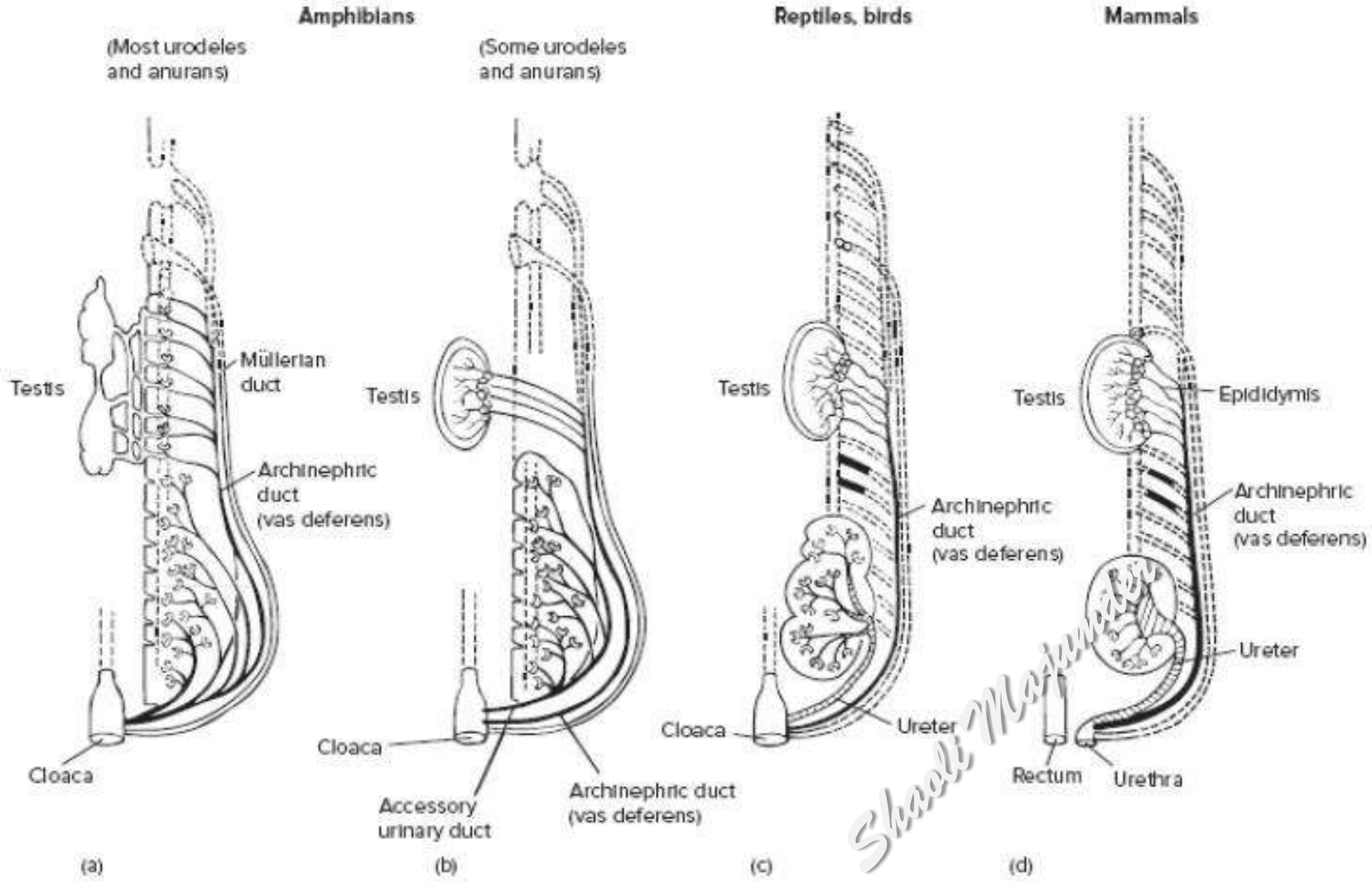
Dr. Shaad Mashood

# Fishes




Dr. Shaoli Majumder

# Tetrapods




Dr. Shadi Mahmoud

**FIGURE 14.35 Urogenital ducts of tetrapod males.** (a) Most urodeles and most anurans (adults). (b) Some urodeles and some anurans (adults). (c) Reptiles and birds. (d) Mammals.