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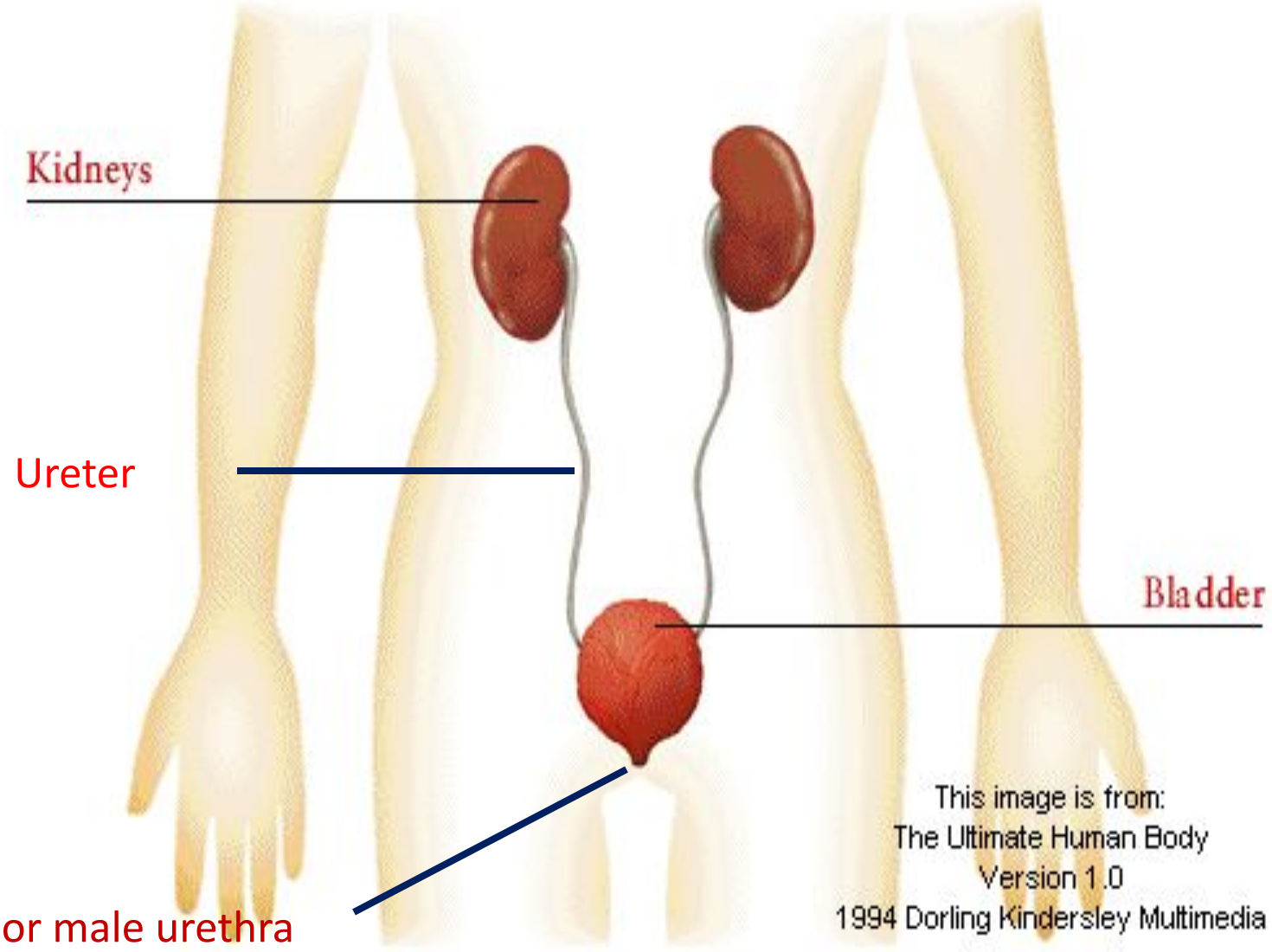
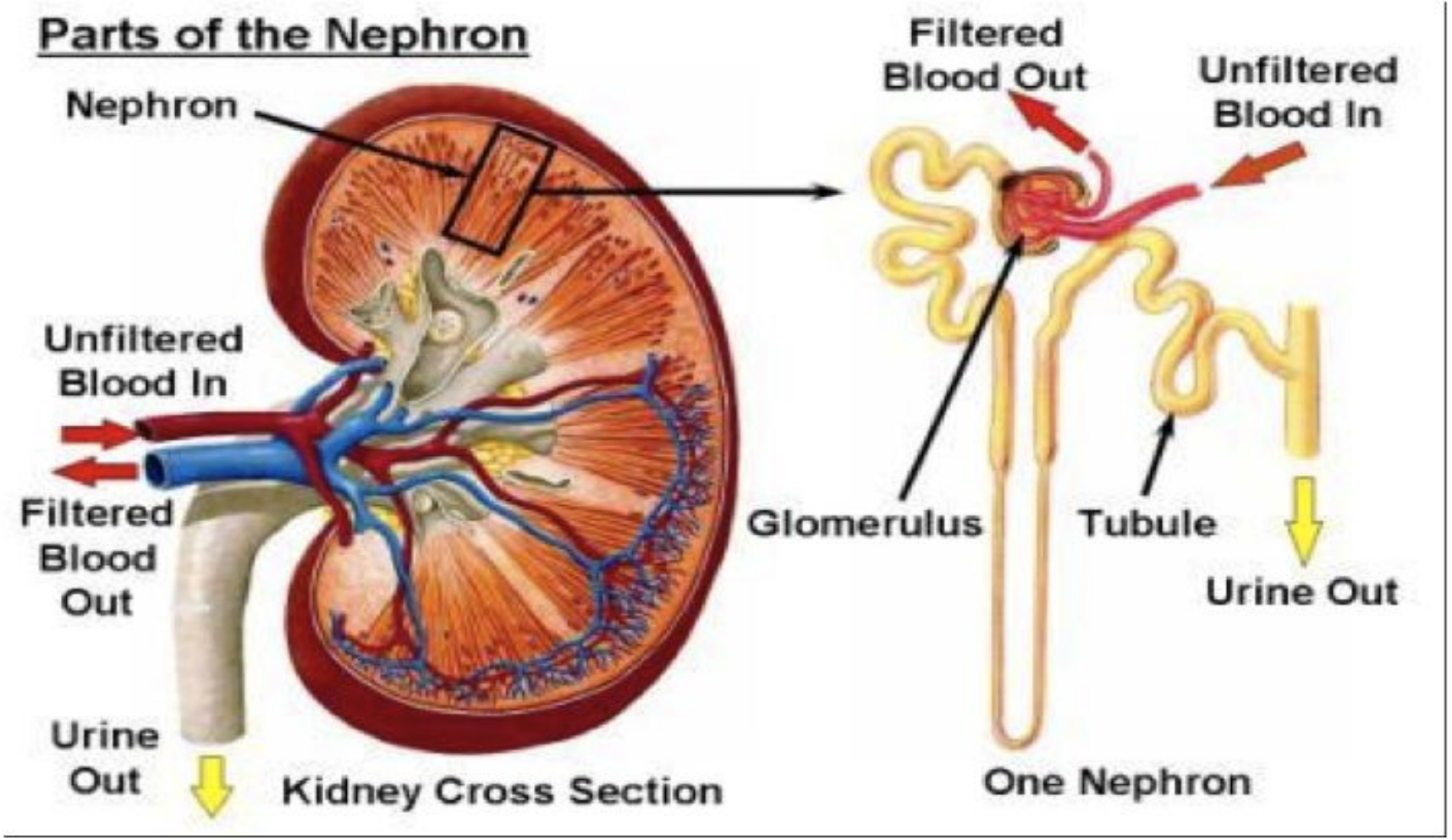
ANATOMICAL & PHYSIOLOGICAL FEATURES OF URINEPOESIS IN CHILDREN. SEMIOTICS OF KIDNEY DISEASES.

Kizima N.V. – M.D., associate professor

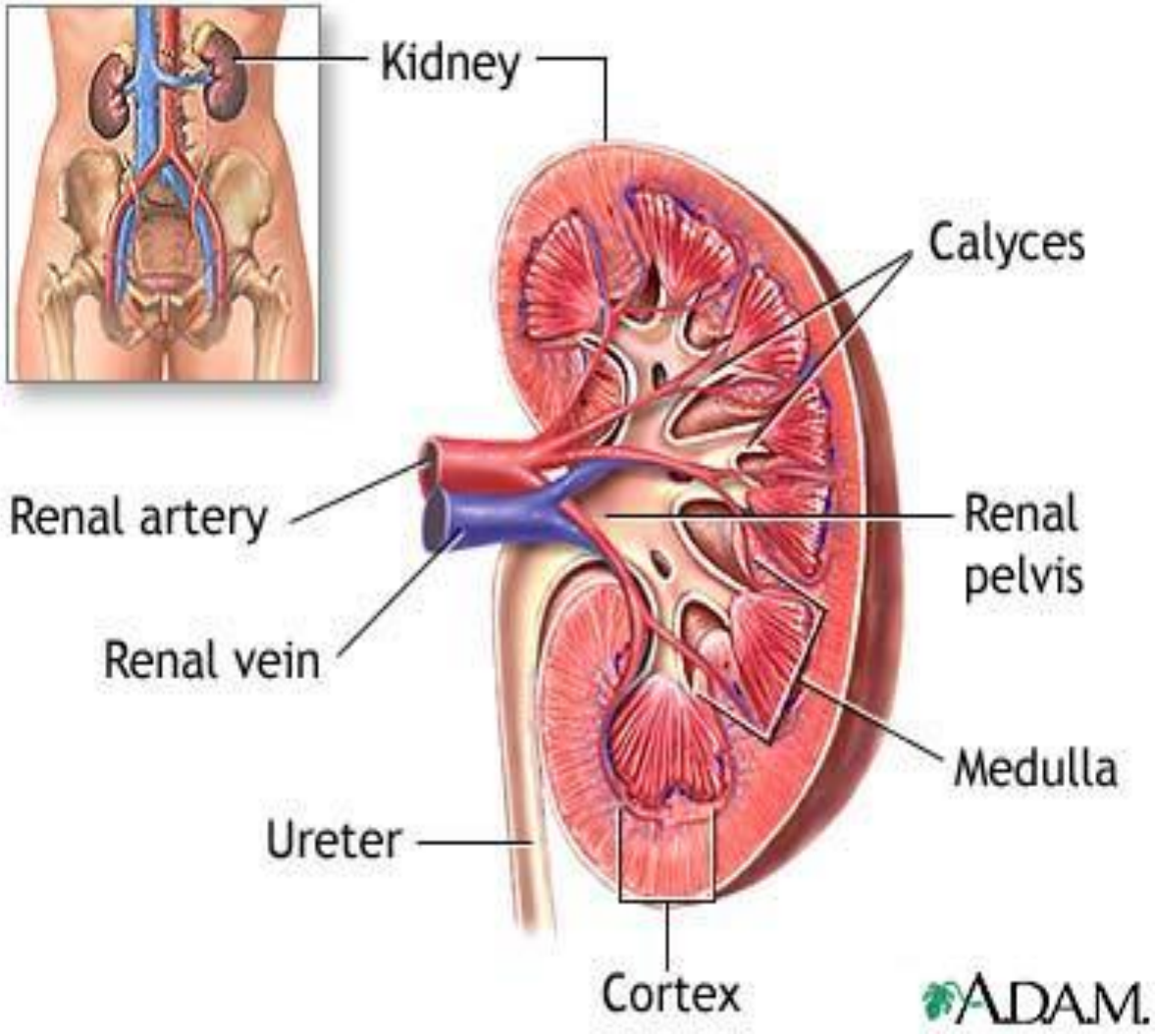


Female or male urethra



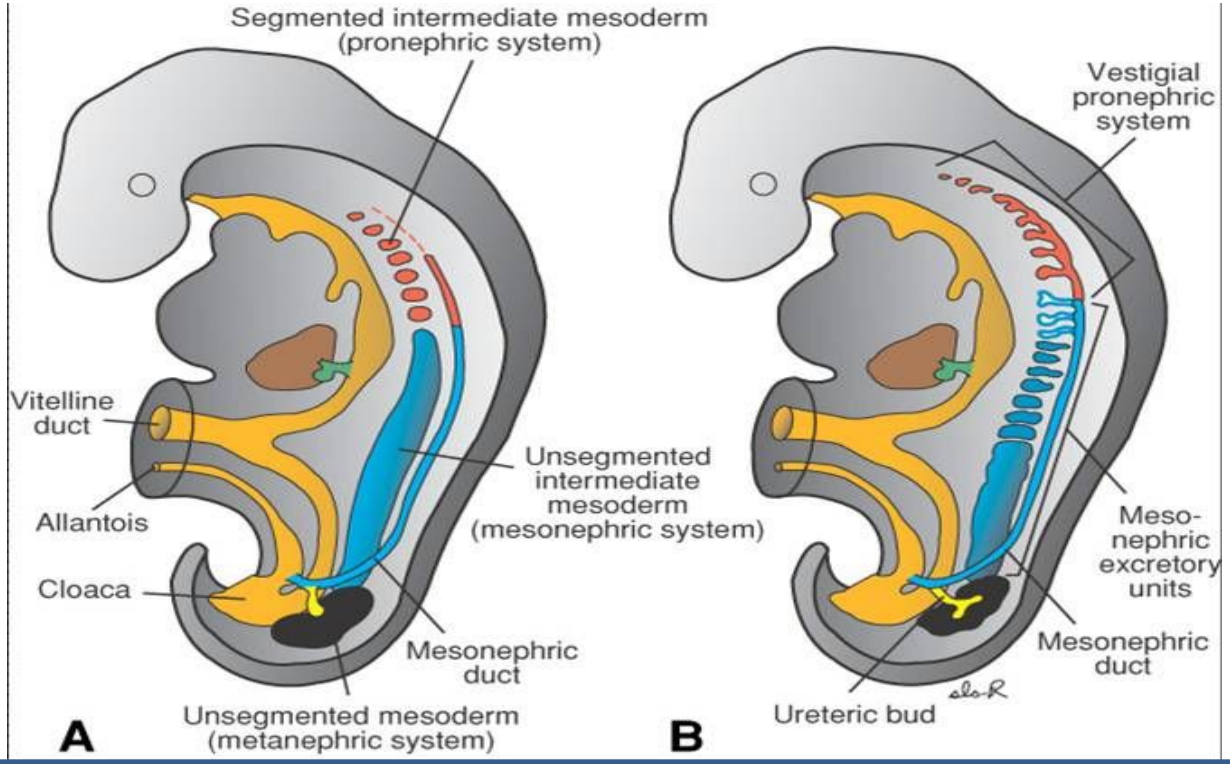
<u>Urine production</u>: main physiological function of kidney .

The **<u>NEPHRON</u>** is the functional unit of the kidney, responsible for the actual purification and filtration of the blood. …and the final product of this process is.... URINE.



<u>Urination (</u>passing out**<u>) organs of the urinary tracts</u> (colligation renal tubes, calyx-pelvis system of the kidney, ureter, urinary bladder, female or male urethra).**

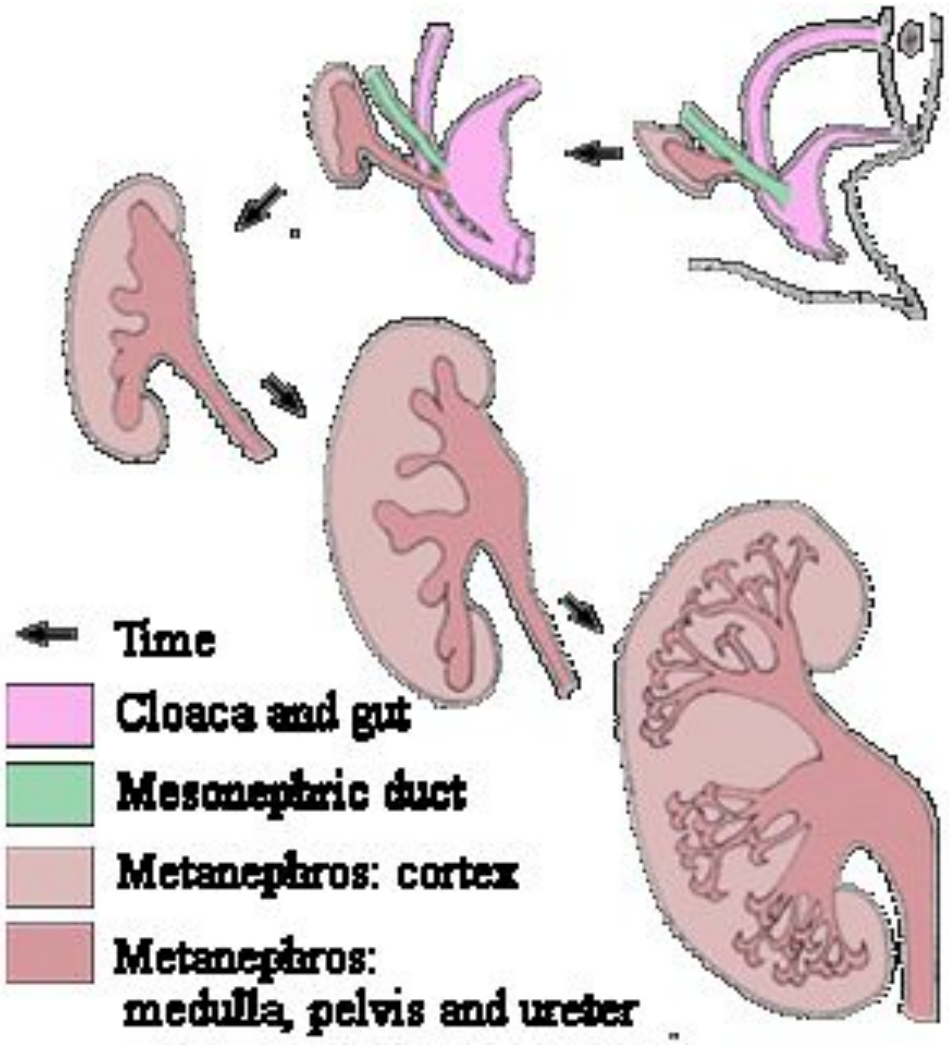
THE URINARY SYSTEM EMBRYOGENESIS



NOTE: pronephric system are at the superior (cervical region) portion, mesonephric system at the middle portion and the metanephric system at the inferior (sacral region) portion of the embryo). Mesonephric duct opens into the urogenital sinus.
Yellow: endodermal (gut)
Blue: intermediate mesoderm (kidney & genital)

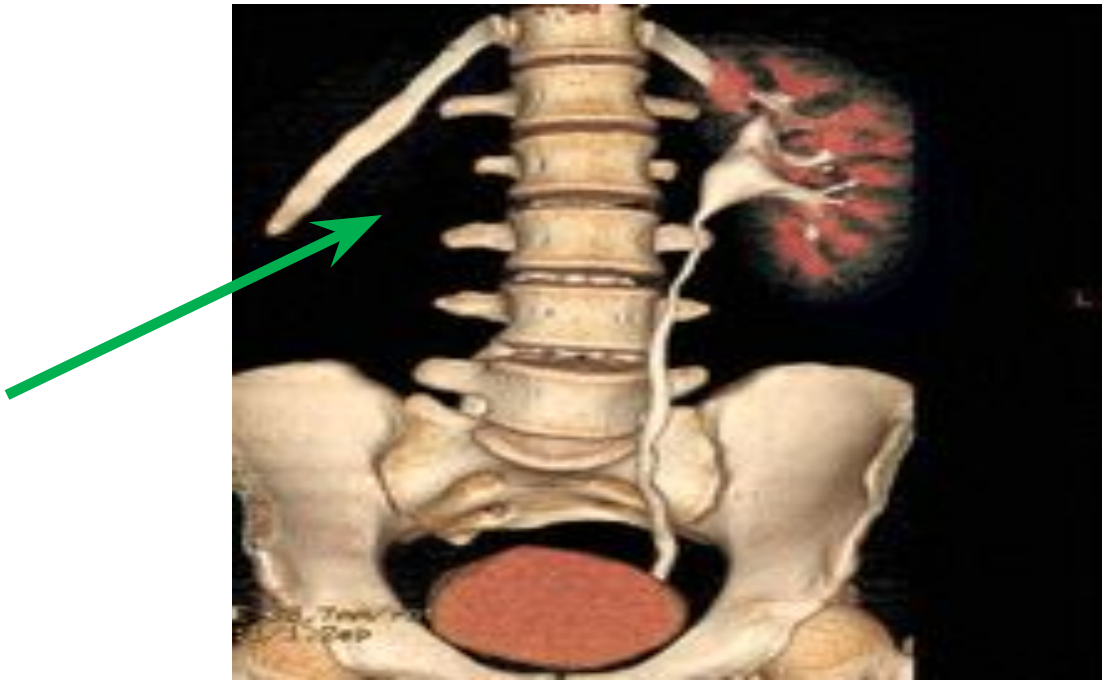
Adult Derivatives of Embryonic Kidney Structures

Embryonic Structure	Adult Derivative
Ureteric bud (metanephric diverticulum)	- Ureter - Renal pelvis - Major and minor calyces - Collecting tubules
Metanephric mesoderm	- Renal glomerulus + capillaries - Bowman's capsule - Proximal convoluted tubule - Loop of Henle - Distal convoluted tubule



This image depicts the development of the metanephros to the adult kidney

THE TYPES OF CONGENITAL DEVELOPMENTAL PATHOLOGY OF KIDNEY.



CT urogram shows single kidney with single ureter.

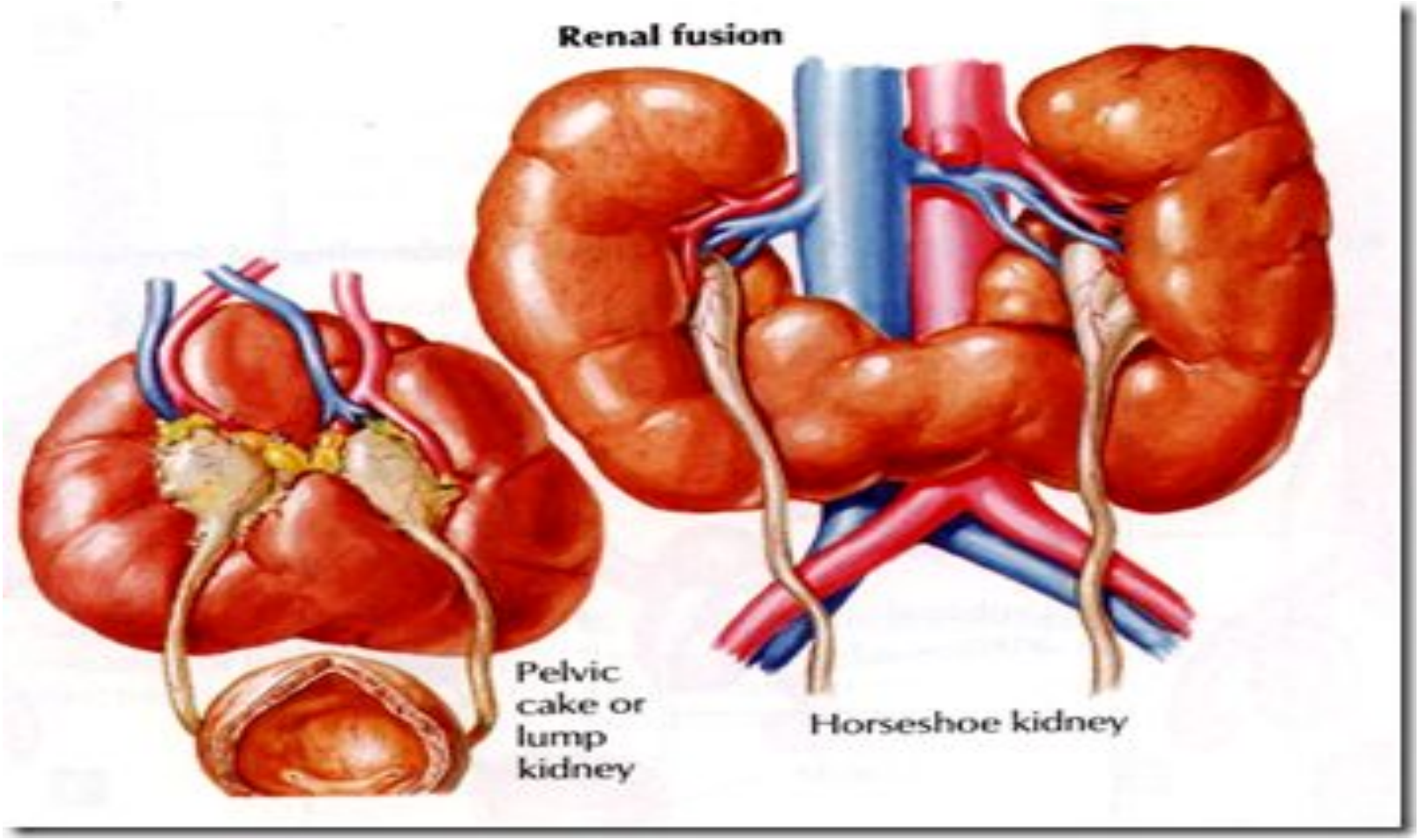
Renal agenesis - the kidney and ureter are absent .

Renal aplasia - the kidney is absent but ureter is present.

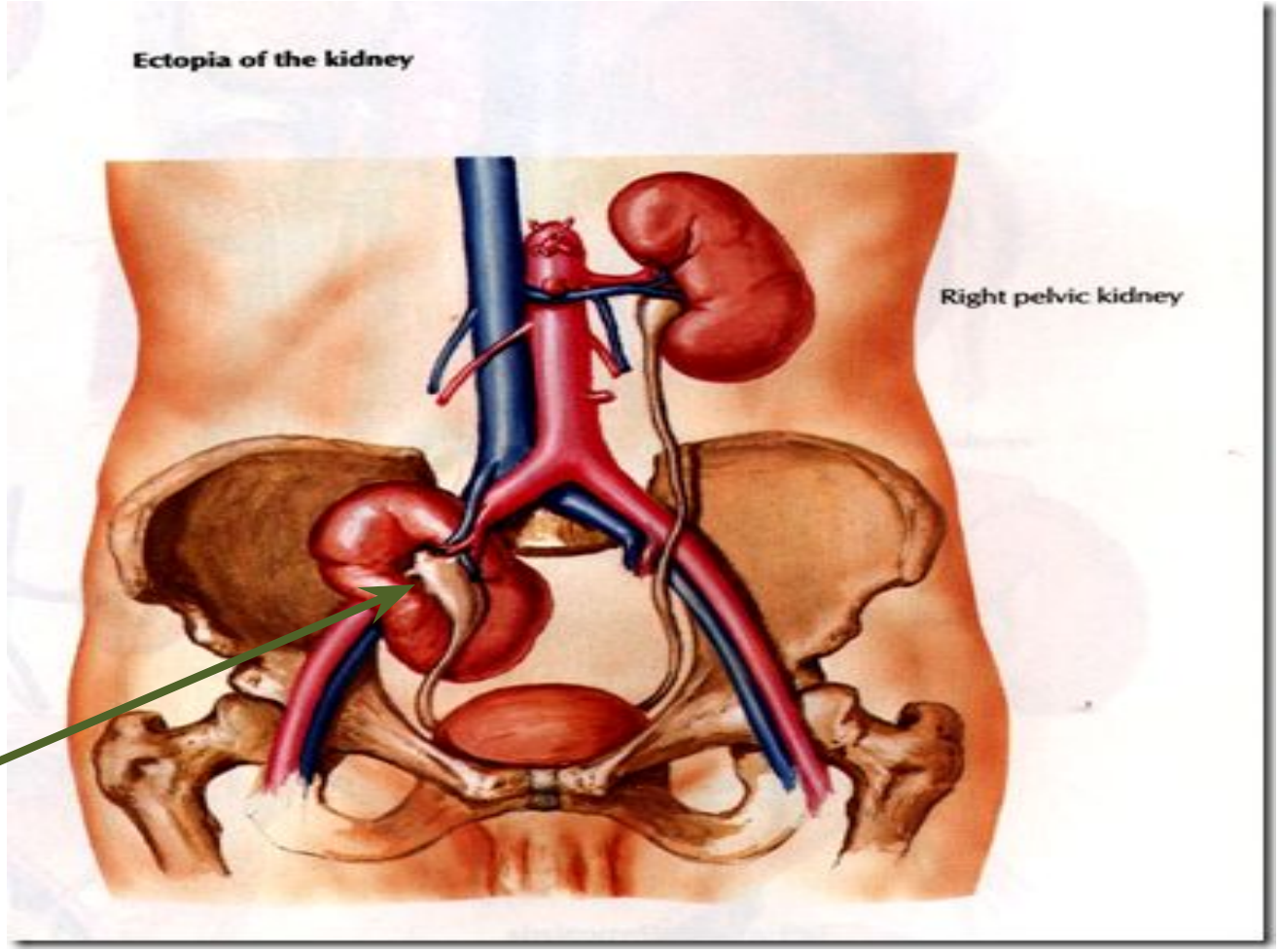
Characteristic physical deformations as <u>Potter facies:</u>

flattened nose, low-set ears, thickened, tapering fingers

Congenital **<u>arthrogryposis</u>** syndrome **<u>(abnormal deformed joints):</u>**
The severe limbs deformations should be explained by uncomfortable fetal position in utero due to small amount of amniotic fluids.



The unusual arrangement renal premordium or unusual direction of ureter`s growth lead to anomalies of renal localization like **lump kidney … horseshoe kidney**



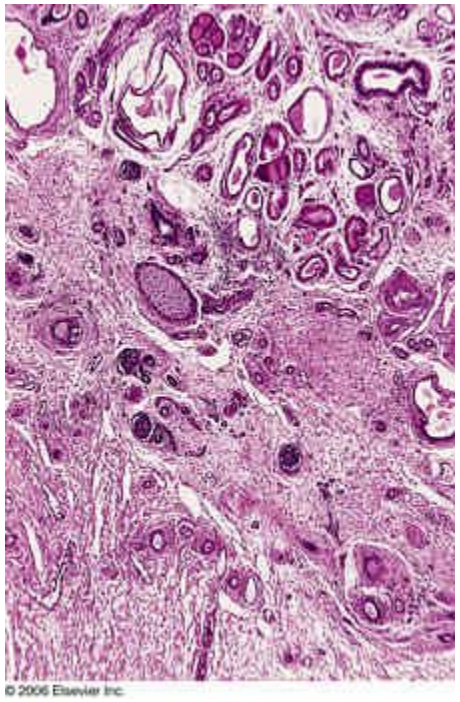
… Right pelvic kidney …

RENAL CORTICAL DYSEMBRIOGENESIS

means anomalies and defects of a histological structure of kidney

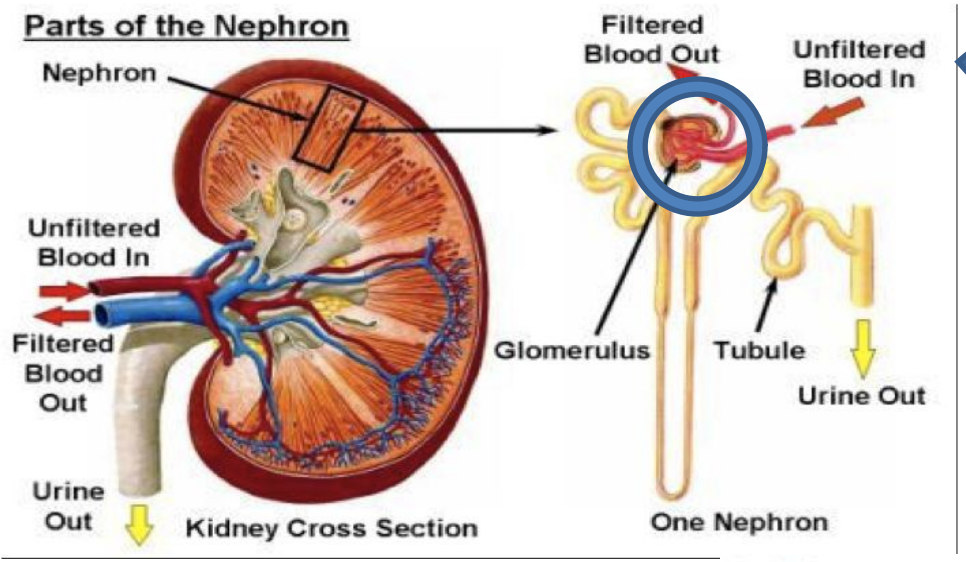
In kidneys by light or electronic microscopy can be met:

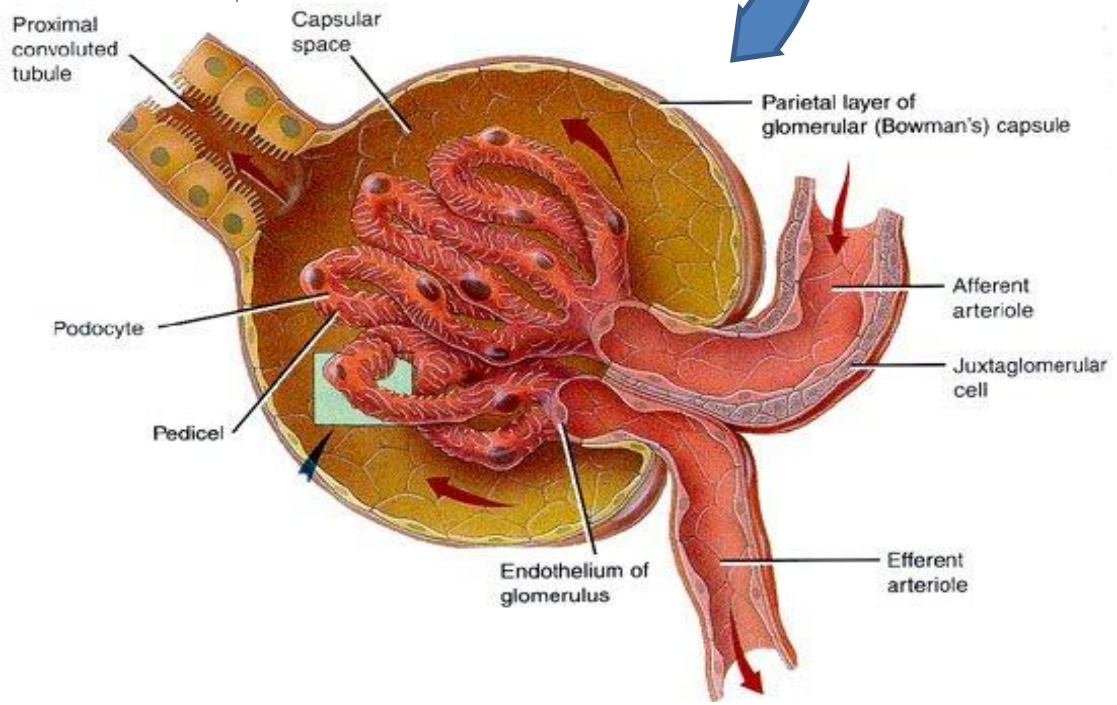
- the **primitive embryonal renal tubules**;
- the **immature renal corpuscles** (nephrones);
- the focuses of **metaplastic cartilage** (it replaces the normal renal tissues);
- the **cysts**.

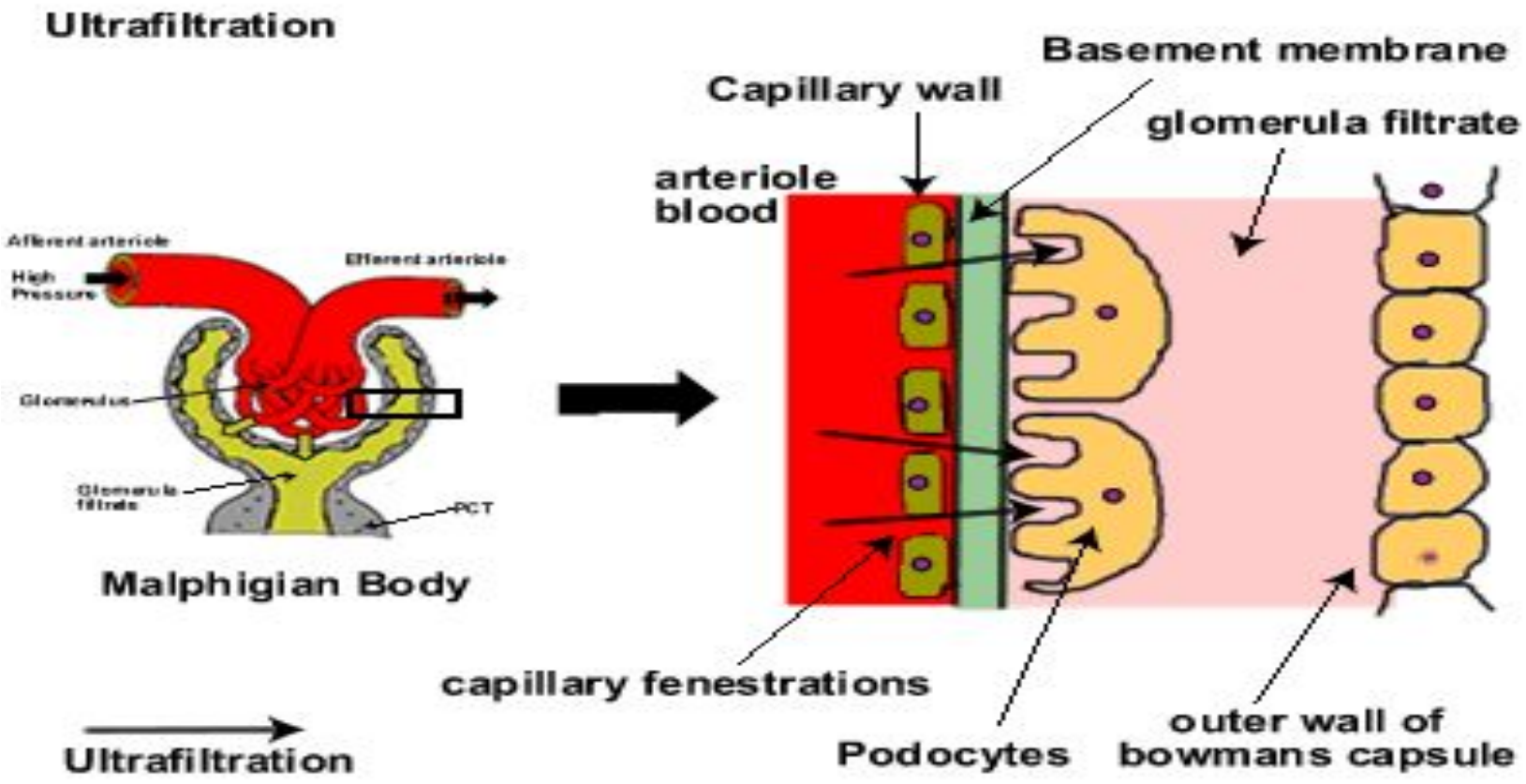


***Multicystic Renal Dysplasia*: Disorganized development of kidney characterized by cystic kidney showing primitive glomeruli, tubules and mesenchyme.**

MORPHOLOGICAL AND FUNCTIONAL FEATURES OF KIDNEY

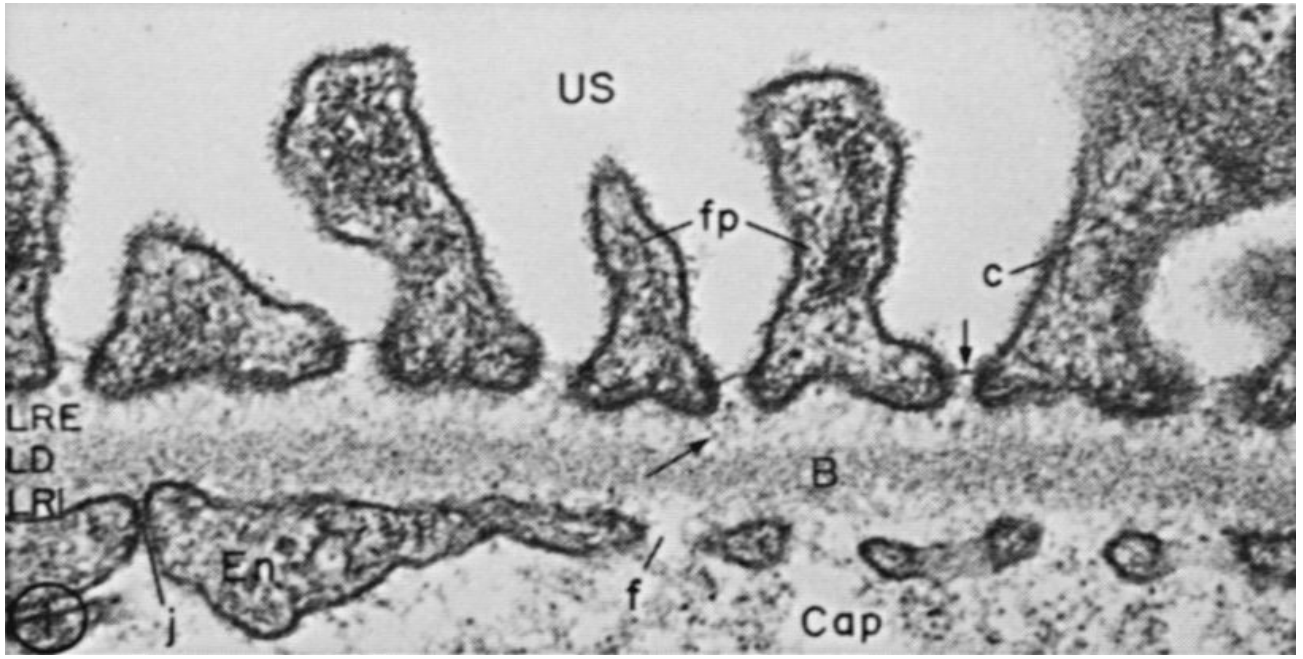




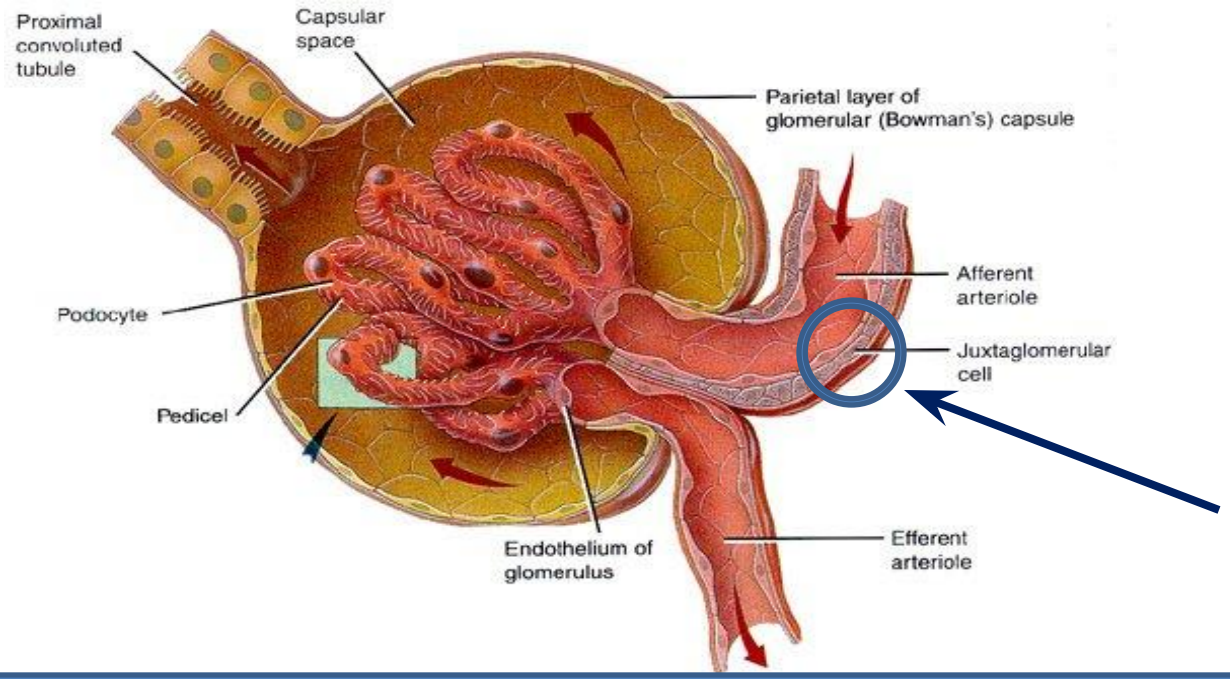


<u>The glomerular filter consists from:</u>

- **the endothelium of blood capillary (capillary wall);**
- **the basement (glomerular) membrane;**
- **the podocytes** (epithelial cells)
- Bowmans capsule



Electron micrograph (x 60,000) of the normal glomerular capillary (Cap) wall demonstrating the endothelium (En) with its fenestrations (f), the glomerular basement membrane (B) with its central dense layer, the lamina densa (LD) and adjoining lamina rara interna (LRI) and externa (LRE;long arrow) and the epithelial cell foot processes (fp) with their thick cell coat (c). The glomerular filtrate passes through the endothelial fenestrae, crosses the basement membrane, and passes through the filtration slits (short arrow) between the epithelial cell foot processes to reach the urinary space (US). J is the junction between two endothelial cells.

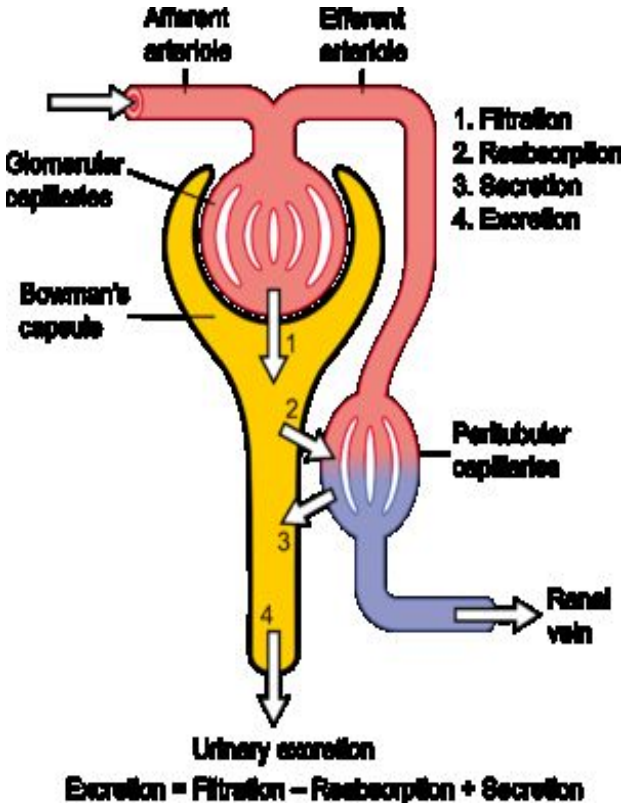


Special cells with granules are **juxteglomerular complex (JGC) in afferent arteriole wall.**

JGC takes part in formation of the renal **arterial hypertension** due to glomerulonephritis (inflammatory disease of glomerule) and others disease in which the blood circulation in renal glomerular capillary is broken.

Physiological bases of uropoiesis in children

afferent arteriole → blood → and aqueous was te s pri



Bowman's capsuse

PROXIMAL CONVOLUTED TUBULE

LOOP OF HENLE

DISTAL CONVOLUTED TUBULE

UR IN E in to col lig ati

blood → efferent arteriole

1. the return absorption **(reabsorption)** in blood from primary filtrate of the main part of water;
2. the back utilization of organic substances and salts which are needed for body;
3. the unneeded for body metabolic substances excretion (through up) in urine.

RENAL FUNCTIONS TESTS IN CLINIC

CREATININE IN SERUM

When kidneys are working properly, serum Creatinine level is low but with renal function impaired – Creatinine level increases.

→ Normal date: 0,053-0,106 mmol/L

GLOMERULAR FILTRATION RATE (GFR) describes the flow rate of filtered fluid through the kidney.

The total amount of creatinine excreted in urine in a 24 hour period is called creatinine clearance.

→ Normal date: 80-120 ml/min

RENAL FUNCTIONS TESTS IN CLINIC

SPECIFIC GRAVITY (concentration) → **Normal date:**
Newborn – 1.001-1.020
Thereafter – 1.016-1/020

TUBULAR REABSORPTION → **Normal date:**
97-99 %

DIFFERENCES OF THE REABSORPTION AND SECRETIONS IN CHILD

The water-remuving function of kidneys is very special. The kidneys **of newborn** are not capable to release the organism quickly both from surplus of water and salts.

An immaturity of renal tubular system in newborns and early children explains **low intensity of antibiotics clearance**.

CLINICAL SIGNS OF RENAL DISEASES

The pain in abdomen or in the back

The urination frequency decreasing or increasing and change color of urine

THE EDEMA

THE ARTERIAL HYPERTENSION

PALPATION OF ENLARGED AND PAINFUL KIDNEYS

SEMIOTICS OF URINE SYNDROME IN DISEASES OF NEPHRON

The **diuresis** is urinary excretion volume in time.

THE DAILY DIURESIS
25-50ml/kg of body weight per day

THE HOURLY DIURESIS
1-2ml/kg of body weight per hour

SEMIOTICS OF URINE SYNDROME IN DISEASES OF NEPHRON

DISORDERS OF DIURESIS:

OLIGURIA (insufficient urinary excretion) is **urine out put less then 1 ml/kg of body weight per hour in small children and less than total 500 ml per day in adults**.

ANURIA is severe decreasing of daily diuresis less than **1/15** from minimal normal level or in patient which does not void long time having the empty bladder.

NOCTURIA **is** abnormally excessive urination during the night.

The protein excretion with urine up to 100 mg/ day is physiological normal value for children.

PROTEINURIA is pathological date of proteins in urine as result of GM usually and other elements of renal filter lesions.

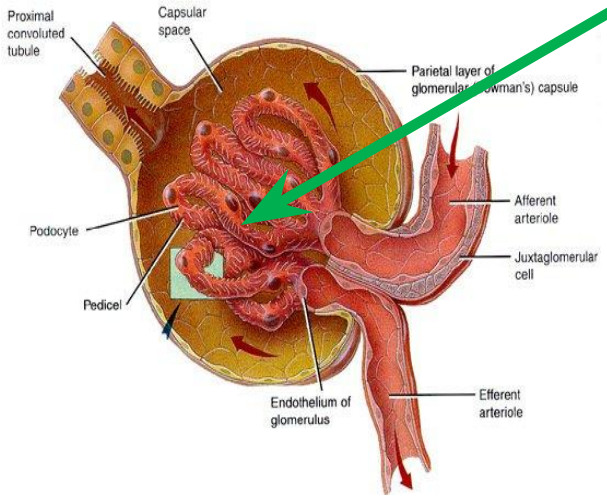
The **SELECTIVE PROTEINURIA means only albumins presents in urine.**

NON-SELECTIVE PROTEINURIA – all types of proteins present in urine.

Functional Proteinuria:

- ***Orthostatic proteinuria*** is finding in children long time standing in vertical position (or walking) and disappearing in horizontal position.
- ***Proteinuria of physical exercise***
- ***Feverish proteinuria***
- ***Transitory proteinuria***

Proteinuria as symptom kidney`s and other diseases



The Glomerular Proteinuria.

In this condition the glomerular filter starts to pass through big amount of protein macromolecules. (Ex.: nephrotic syndrome, **glomerulonephritis**)

Proteinuria as symptom kidney`s and other diseases

The Tubular Proteinuria

as result the damaged nephron tubular system should not reabsorb the normally filtered proteins. (Ex.: de Toni-Debre—Fanconi disease)

Prerenal proteinuria

or proteinuria "of serum proteins overload" is due to superfluous accumulation in blood of low-molecular proteins (like light chains of antibodies, hemoglobin, myoglobin, fibrinogen degradation products and others)

HEMATURIA is the presence of red blood cells (erythrocytes) in the urine more than normal date.

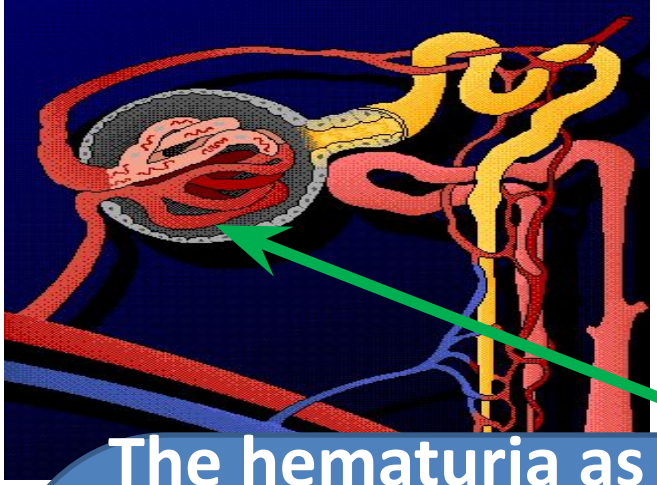
NORMAL DATE:

Up to 1000 Red Blood Cells in 1 ml of urine by Nechiporenko,

up to 2 Red Blood Cells in microscopic view by urinalysis

PHYSIOLOGICAL HEMATURIA:

- after physical exercises
- orthostatic (postural) hematuria in patient long time standing in vertical position in loin hyperlordosis posture



The hematuria as a symptom as result of blood vessels inflammation in kidney glomerula (ex. **glomerulonephritis**)

It is ***RENAL PAINLESS hematuria*** **.**

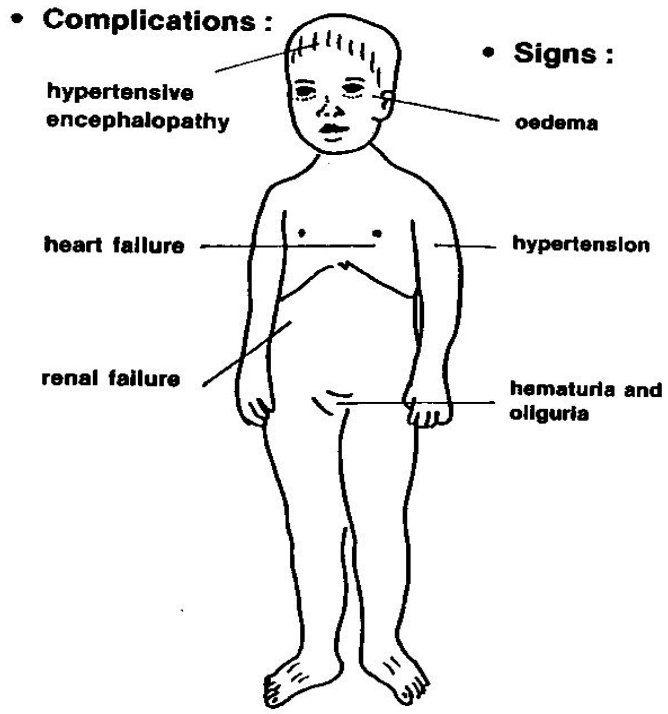
MICROHEMATURIA *should be* detected only by microscopy. In microhematuria the color of urine is not changed.

In **MACROHEMATURIA** the urine containing big amount of red blood cells (smoky or cola color urine).

THE TYPICAL KIDNEYS DISEASES.

The acute glomerulonephritis (postsstreptococcal) is an autoimmune disease following respiratory or skin streptococcal infection caused by group A β-haemolytic streptococcus.

Start in children after 3-5 years. In boys it is more common than in girls.
The disease begins **1-3 weeks after the onset of streptococcal** throat or skin infection **infection.**



THE ACUTE GLOMERULONEPHRITIS clinical signs

Intoxication:

mild fever*, *anorexia* (refusal of meals), *vomiting* and *headache

<u>Nephritic syndrom</u>:

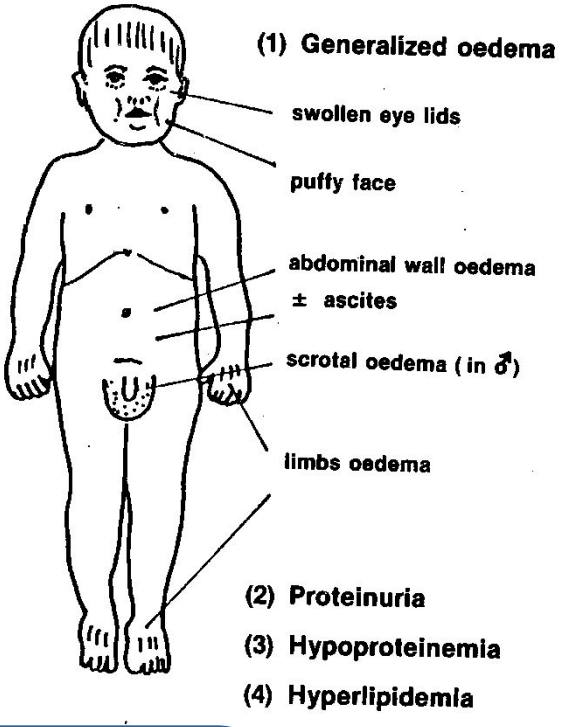
-hematuria

-arterial hypertension

Nephrotic Syndrome

The nephrotic syndrome:

- high proteinuria,
-hypoproteinemia, hypoalbuminemia
-hyperlipidemia
- edema.



The minimal change nephrotic syndrome (renal syndrome with the minimal changes in glomerule revealed by light microscopy) is an independent disease. The onset of disease is uncommon after 7 years.