MEDICINE-RENAL
NEET-SS

CONTENT

00

Leave Feedback

RENAL EMBRYOLOGY

Development of urogenital system 00:00:37

Entire urogenital system is derived from intermediate mesoderm >> cloaca.

Cloaca is part of the hindgut that is distal to the allantois.

Cloaca is completely endodermal in origin. It gives rise to two structures namely primitive urogenital sinus and primitive rectum.

Primitive rectum : Gives rise to rectum and anal canal up to pectinate line.

Anal canal below pectinate line is ectodermal in origin.

Primitive urogenital sinus : Gives rise to vesicourethral canal (bladder and urethra).

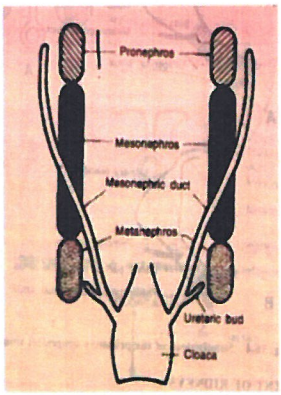
The upper part gives rise to the bladder, pelvic part gives rise to prostatic and membraneous urethra and phallic part gives rise to sponge urethra.

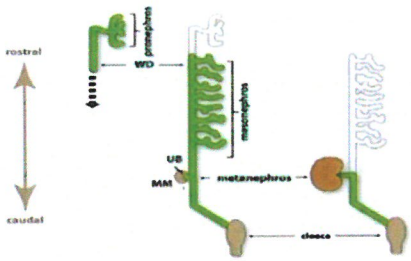
Entire kidney is derived from intermediate mesoderm.

- Paraxial mesoderm : Gives rise to somites (muscles).
- Lateral plate mesoderm: Gives rise to cavities (pleura, peritonium. pericardium..) in the body.
  Somatopleuric gives rise to parietal pleura, parietal pericardium, etc.
  Splanchnopleuric gives rise to visceral pleura, visceral pericardium, etc. m
- Intermediate mesoderm: Gives rise to,
  1. Genital ridge (gonads).
  2. Paramesophric duct (mullerian duct).
  3. mesonephric duct/wolffian duct.
  4. Urogenital ridge : Is called as nephrogenic cord. It extends from the cervical to sacral region of the embryo. It is very closely aligned to the wolffian duct.

Active space

Leave Feedback





Structures derived from mesonephric duct:

- Seminal vesicle.
- Ejaculatory duct.
- Vas deferens.
- Trigone of the bladder(entire bladder is endodermal in origin except trigone).
- Appendix of epididymis.
- Ureteric bud.

Remnants of mesonephric duct are Gartner's cyst, epoophoron and paroophoron.

Remnants of paramesophric duct are appendix of testis and hydatid of morgagni.

Urogenital ridge and ureteric bud 00:08:19

From the urogenital ridge :

- Day 22 : Pronephros appears and regresses in 2-3 days.
- Day 24 : mesonephros appears and regresses in 4 months.
- 5th week : metanephric mesenchyme (forms the excretory part of the kidney).
- 5th week : Ureteric bud develops from the mesonephric duct (forms the collecting part of the kidney).
- Between 6th to 8th week : Epithelial (of ureteric bud)

Active space

mesenchymal interaction occurs.

- End of the 8th week : First fully formed nephron.
- 9-10th week : Urine formation starts.
- 32-36 weeks : Nephrogenesis is completed.
- 18 months : Fetal kidney reaches adult concentrating capacity.

After birth, new nephrons are not formed, and lost nephrons cannot be replaced.

Concentrating capacity is increased even after the birth. At 18 months, adult concentrating capacity is reached.

60% of nephrons are formed in third trimester.

GFR = Single nephron GFR x number of nephrons.

CKD : Decrease in nephron number.

3 kg at birth : 9,00,000 nephrons in each kidney.

2 kg at birth : 2,25,000 nephrons in each kidney.

Birth weight determines the number of nephrons at birth, after which new nephrons are not formed.
Therefore premature babies are prone to CKD.

Mother's average BP during pregnancy determines birth weight.

Epithelial mesenchymal interaction 00:16:34

Epithelial mesenchymal interaction (EMI) is made possible by transcription factors which is expressed from the ureteric bud side or metanephric mesenchyme side.

Transcription factors are required for the ureteric bud induction.

Transcription factor required for ureteric bud induction : PAX-2 (mutation causes unilateral renal agenesis).

Homozygous mutation leads to bilateral renal agenesis.

Active space

Leave Feedback

Transcription factors expressed by the :

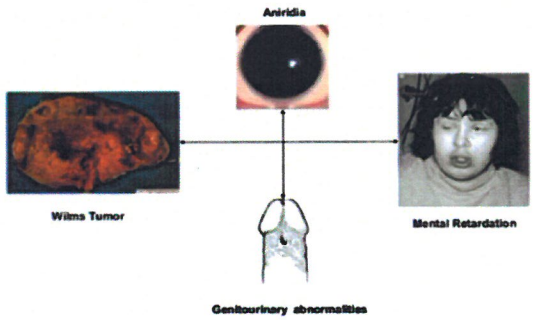
- metanephric mesenchyme : WT1, WNT4 and WNT6.
- Ureteric bud : FGF, BMP-7.

WT1 gene on chromosome 11p : Mutation leads to

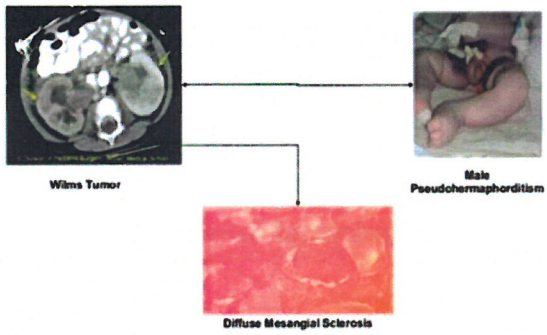
- WAGR syndrome.
- Denys Drash syndrome.

WAGR syndrome and Densh Drash syndrome 00:19:24

WAGR syndrome :



Denys Drash syndrome :



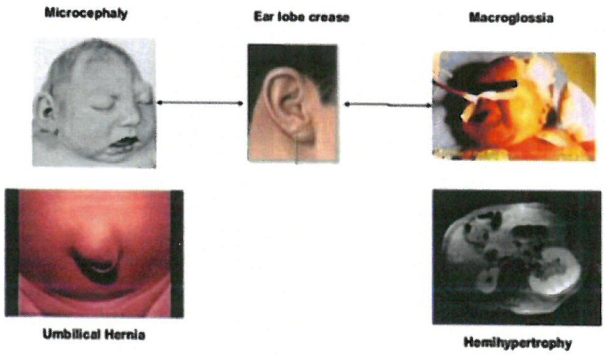
Characterized by :

- Wilms tumor.
- Male pseudohermaphordism and
- Early onset renal failure (diffuse mesangial sclerosis).

Active space

Beckwith-Wiedmann syndrome 00:20:15

Beckwith-Wiedmann syndrome is not a part of EMI.

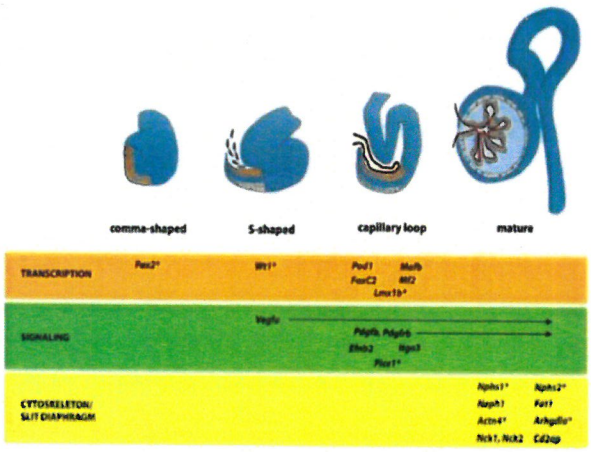


Due to WT2 gene mutation on chromosome 11.

Genomic imprinting abnormalities are present.

Clinical features :

- Organomegaly (renomegaly, nephromegaly, adrenomegaly, hepatomegaly).
- Omphalocele/umbilical hernia.
- macroglossia.
- Hemihypertrophy of testes (very closely associated with medullary sponge kidney).



VEGF is produced by the podocytes and is required for this progression.

Active space

Leave Feedback

TABLE 50.1 Monogenic Causes of CAKUT

Stage of Nephrogenesis	Gene	Associated Phenotype
Ureteric bud induction	*EYA1*	Branchio-oto-renal syndrome
	GATA3	HDR syndrome
	PAX2	Renal coloboma syndrome, FSGS
	RET	Renal agenesis and Hirschsprung disease
	ROBO2	VUR
	SALL1	Townes-brocks syndrome
	SIX1, SIX5	Branchio-oto-renal syndrome
Mesenchymal to epithelial transition	*WNT4*	Renal hypodysplasia, müllerian aplasia, hyperandrogenism
	SIX2	Renal hypodysplasia
Branching morphogenesis	*ACE*	All associated with renal tubular dysgenesis
	AGT	
	AGTR1	
	REN	
As yet unknown	*HNF1B*	Renal cysts and diabetes syndrome, genital malformations, hypomagnesaemia, abnormal LFTs, gout, autism
	DSTYK	CAKUT
	TNXB	VUR, joint hypermobility
	SOX17	VUR
	KAL1	Kallman syndrome
	FRAS1	Fraser syndrome
	FREM2	Fraser syndrome
	GRIP1	Fraser syndrome

WNT4 and WNT6 mutation can produce :

- Renal hypodysplasia (<2 SD size).
- Hyperandrogenism
- Mullerian aplasia.

ACE mutations are associated with tubular dysgenesis.

HNF1B mutations are associated with MODY 5, renal cysts, genital abnormalities.

Metanephros (adult kidney) : It is initially formed at the level of S1-S2. At around 9-10th week, ascend with rotation occurs and reaches T12-L3 level.

Unilateral renal agenesis 00:26:40

Heterozygous PAX-2 mutation: Unilateral renal agenesis with optic coloboma.

Incidence: 1 in 1000 live births.

Common in females >> males.

HTN is only the clinical feature.

Active space

Malformations associated with unilateral renal agenesis :

- Single umbilical artery.
- Absent uterus.
- Absent ipsilateral vas deferens.
- Contralateral vesico-ureteral reflex.

Contracted Kidneys from birth : **Multicystic dysplastic Kidney.**

RET/GDNF gene mutation is associated with : **Bilateral renal agenesis .**

Bilateral renal agenesis associated with : **Oligohydramnios** and **Potter's** syndrome (bilaterally absent renal artery, disc shaped adrenals).

Cakut anomalies

00:28:02

Common congenital anomalies of Kidneys and urinary tract.

m/c ESRD in children.

It includes:

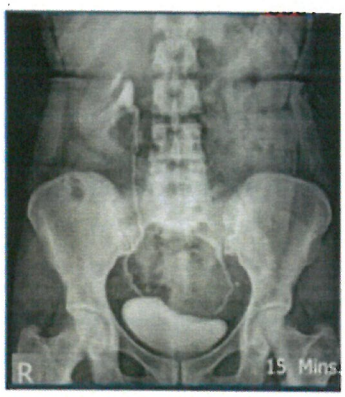
Agenesis : It can be unilateral or bilateral.

Dysplasia : Abnormal differentiation. Example : Multicystic dysplastic Kidney (unilateral).

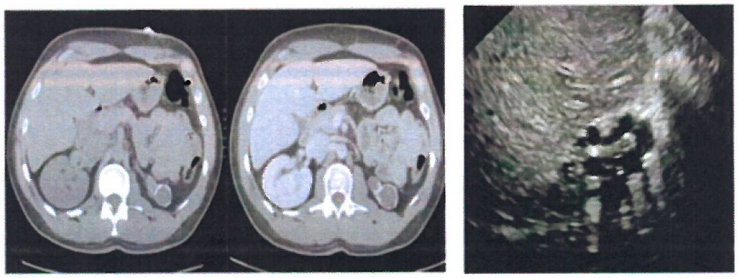
Hypoplasia : Decrease in size of Kidney with normal or oligomeganephronia (decreased nephron number) : Remaining glomeruli undergo hypertrophy).

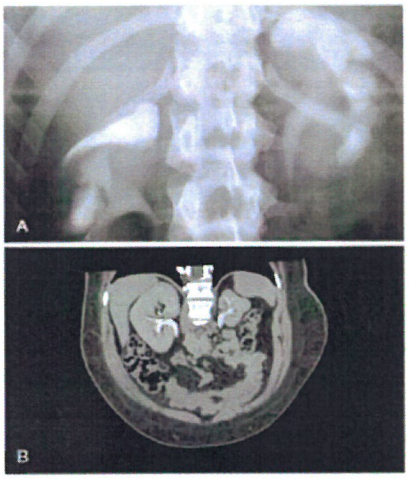
Segmental hypoplasia : Associated with HTN in young (ask up mark Kidney).

Ectopic Kidney

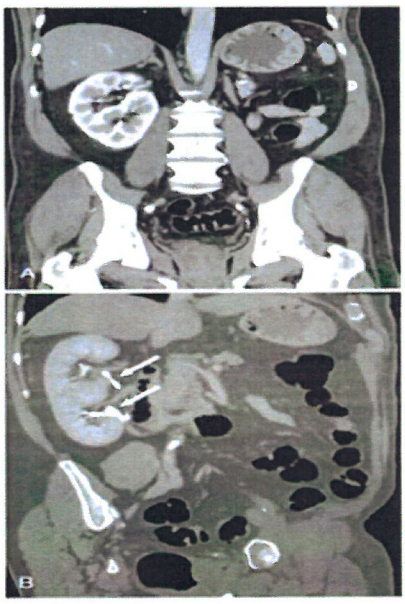


Leave Feedback





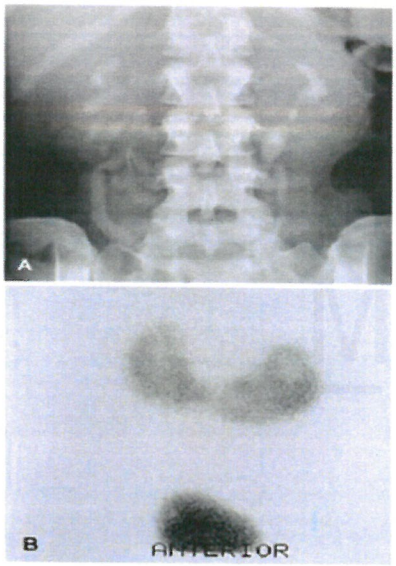
multicystic dysplastic kidney



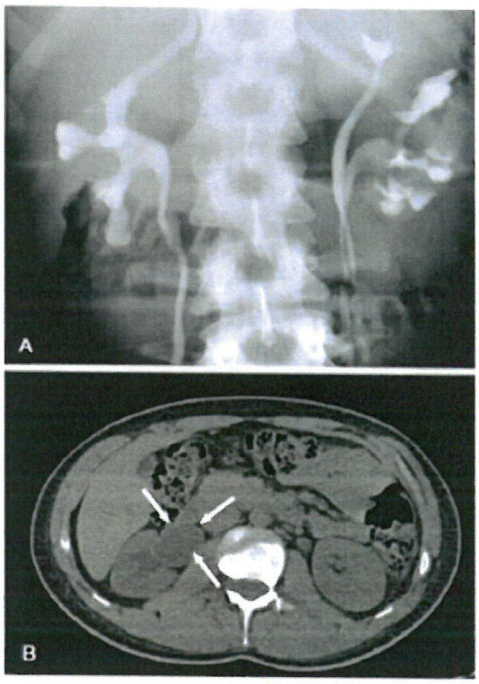
Cross fused ectopic kidney

Active space

Leave Feedback



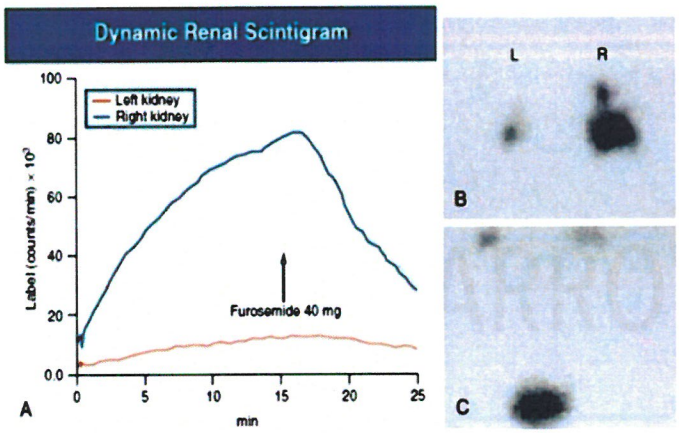
Horseshoe Kidney



Duplex system

Active space

Leave Feedback



Tc-99m MAG3 renogram

Technetium-99m MAG3 scintigram is used to detect PUJ stenosis.

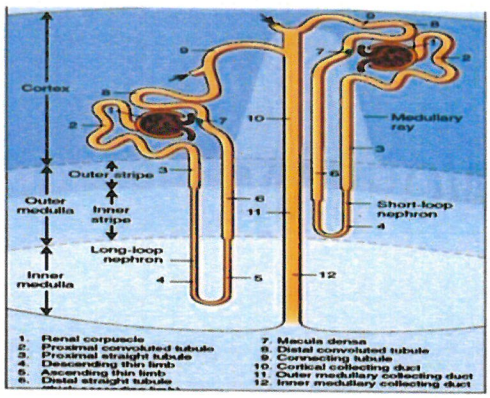
Active spac

RENAL ANATOMY

Definitions

00:00:20

Section	Subsections
Nephron	
Renal corpuscle	Glomerulus : The term used most frequently to refer to the entire renal corpuscle. Bowman's capsule
Proximal tubule	Convoluted part. Straight part (pars recta) or thick descending limb of Henle's loop.
Intermediate tubule	Descending part or thin descending limb of Henle's loop. Ascending part or thin ascending limb of Henle's loop.
Distal tubule	Straight part or thick ascending limb of Henle's loop : Subdivided into medullary and a cortical part; the latter contains in its terminal portion the macula densa. Convoluted part.
Collecting duct system	
Connecting tubule	Includes the arcades in most species
Collecting duct	Cortical collecting duct : Outer medullary collecting duct subdivided into an outer and an inner stripe portion. Inner medullary collecting duct subdivided into basal, middle, and papillary portions.



Leave Feedback

Structures in the excretory part of Kidney :

1. Glomerulus + Bowman's capsule (renal corpuscle).
2. PCT or pars convoluta.
   The S1 and S2 segments are parts of PCT. Present in the cortex.
3. PST or pars recta.
   S3 segment is present in PST. It is present in the medulla.
   2 + 3 is called proximal tubule.
   The main function of proximal tubule is reabsorption.
   It contains abundant number of mitochondria.
   The tubule is lined by cuboidal epithelium containing brush border microvilli.
   PST is the most susceptible to acute tubular injury because of high oxygen requirement needed for reabsorption.
   Ischemia is the most common cause for acute tubular injury.
4. Thin descending limb of Henle's loop.
5. Thin ascending limb of Henle's loop.
   4 + 5 is called intermediate tubules.
   85% of nephrons are cortical nephrons and 15% of nephrons are juxtamedullary nephrons.
   Cortical nephrons are short looped and juxtamedullary ones are long looped based on the location of tip of the loop of Henle.

   When the tip is at the junction of inner and outer medulla, it is called short looped cortical nephrons.
   When the tip extends till the inner medulla, it is called long looped juxtamedullary nephrons. Its function is concentration of urine.
6. Thick ascending limb of loop of Henle or Distal straight tubule.
8. Distal convoluted tubule.

6 + 8 is called distal tubule.

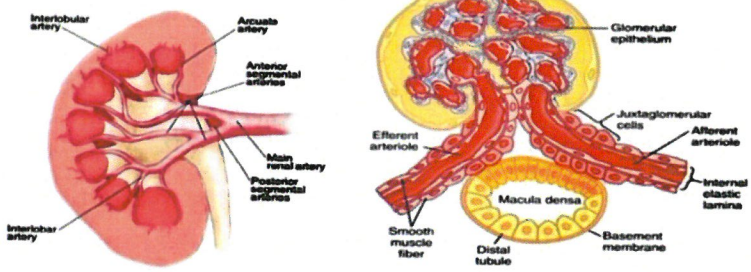
The excretory part of Kidney develops from the metanephric mesenchyme.

Active space

Leave Feedback

Collecting part of the kidney which are derived from ureteric bud :

9. Connecting tubules
10. Cortical collecting duct.
11. Outer medullary collecting duct.
12. Inner medullary collecting duct.



The pelvis and ureter are derived from the ureteric bud.
Urinary bladder is derived from the primitive urogenital sinus or cloaca.
Trigone of the bladder is derived from the mesoderm.
Urethra is derived from the cloaca (endodermal origin).

Macula densa is lined by tall columnar epithelium.
It is present at the cortical portion of thick ascending limb of Henle (DST and DT). The function of macula densa is tubuloglomerular feedback.
Juxtaglomerular apparatus is comprised of three structures :

- Macula densa.
- Mesangial cells (Supporting cells/Polkissen's cells/Lacis cells).
- Granular cells or juxtaglomerular cells seen in the tunica media of the afferent > efferent arterioles.
  They produce renin.

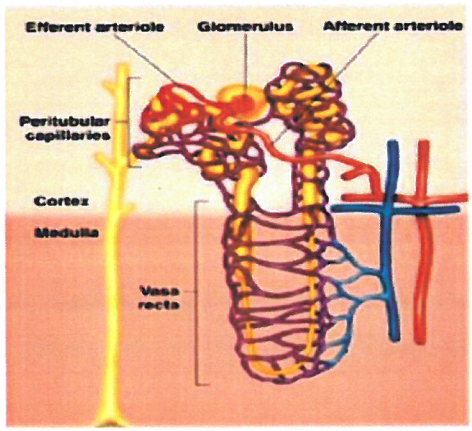
Kidney is supplied by renal artery which is a lateral branch of abdominal aorta. It divides into 5 segmental arteries (4 anterior and 1 posterior).
The segmental divides into → Interlobar arteries → Arcuate

Active space

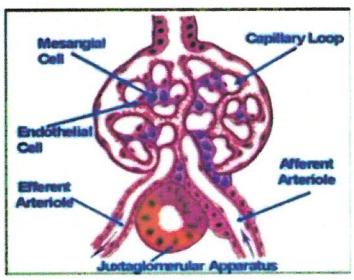
Leave Feedback

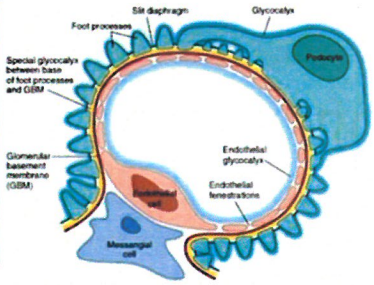
arteries (typically seen at the corticomedullary junction) → Interlobular artery or cortical radial artery from which the afferent arterioles arise → Glomerular capillary plexus → Efferent arteriole → Peritubular capillary plexus → Vasa recta (descending limb followed by ascending limb) → Renal vein → IVC.

The structure sandwiched between the double capillary plexus : Efferent arterioles.



The entire blood supply of the medulla is by the efferent arterioles. The paO_a in the medulla is 10mmHg compared to 60 – 70 mmHg in the cortex.
Conditions like efferent arteriolar hyalinosis seen in diabetes can compromise the blood supply to the medulla.





Anatomy of glomerulus 00:21:47

The innermost layer is the capillary which has a lot of fenestration slits. A single endothelial cell is present. The entire capillary is coated with glycocalyx.

Active space