✅ CKD

🧠 According to the K/DOQI (Kidney Disease Outcomes Quality Initiative): CKD =

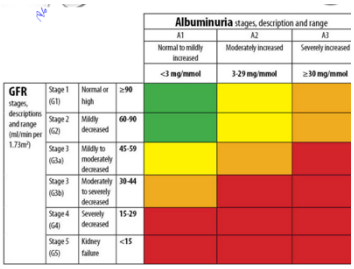
- Kidney damage for **≥3 months** defined by:
  - Structural or functional abnormalities
  - With OR without decreased GFR

📌 Damage is diagnosed by either:

1. **Pathological abnormalities** (biopsy)
2. **Markers of kidney damage**:
   - Blood tests (e.g., ↑urea, ↑creatinine, ↓Hb)
   - Urine tests (e.g., proteinuria, hematuria)
   - Imaging abnormalities (e.g., small echogenic kidneys)

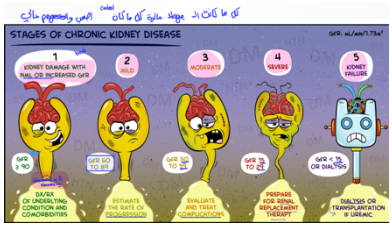
OR:

- GFR ≤60 mL/min/1.73m^2 for ≥3 months (with or without above markers)



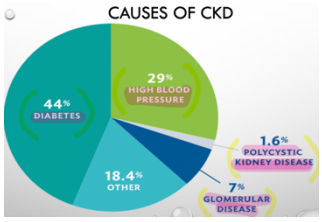
📊 STAGES OF CKD:

Stage	GFR (ml/min/1.73m^2)	Notes
Stage 1	≥90	Normal GFR + persistent hematuria/proteinuria
Stage 2	60–89	Mild ↓GFR + persistent markers
Stage 3	30–59	Moderate GFR ↓
Stage 4	15–29	Severe GFR ↓
Stage 5	<15 or on dialysis	End-Stage Renal Disease (ESRD)



🧪 CAUSES OF CKD:

- Diabetes mellitus (MC cause)
- Hypertension
- Glomerulonephritis (e.g., SLE, IgA)
- Polycystic kidney disease
- Chronic interstitial nephritis (e.g., NSAID-induced)
- Obstructive uropathy



📉 PROGRESSION OF CKD:

Monitoring GFR decline helps predict the time to (ESRD) and evaluate treatment effectiveness.

- GFR declines **progressively over time**
- Must estimate GFR decline to:
  1. Predict when ESRD will occur
  2. Assess effectiveness of therapy to slow GFR

How?

- Track **serum creatinine (past and ongoing)**
- Identify **risk factors** for fast progression (e.g., proteinuria, hypertension)
- Consider interventions in **all** CKD patients

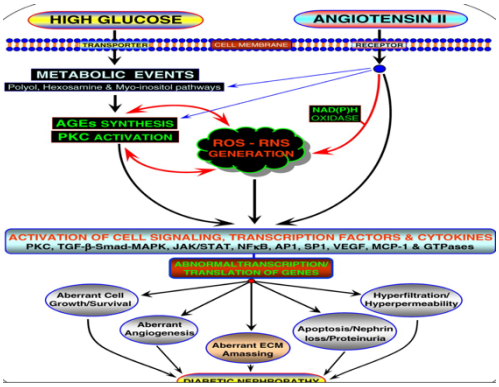
📌 Creatinine should be checked **yearly** at minimum, or more frequently if:

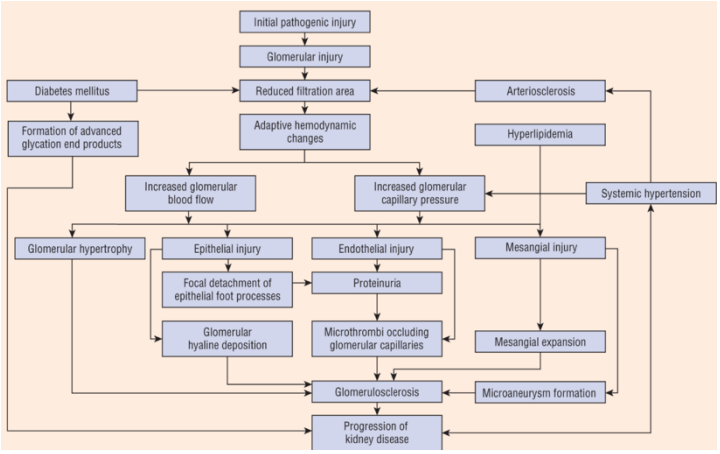
- GFR <60
- Past GFR decline >4 mL/min/year (past)
- Exposure to risk factors for acute GFR decline and for faster progression
- On therapy to slow progression

🧬 CKD PATHOPHYSIOLOGY:

1. Initial Injury: e.g. GN, ATN, AIN, PCKD
2. ➡️ Loss of nephrons (parenchyma)➡️ Compensatory hyperfiltration (↑ PGC (Glomerular pressure) ➡️ ↑ SNGFR ➡️ ↑ Wall stress➡️ ↑TGF-β
3. Long-term damage to remaining nephrons

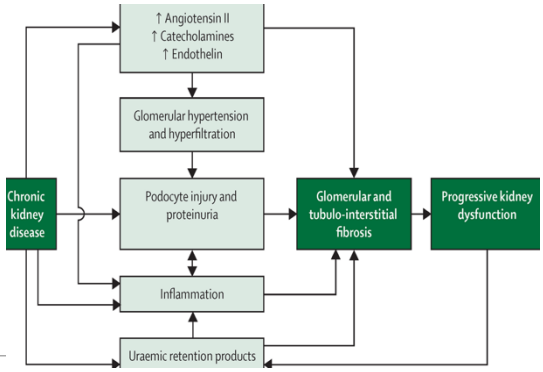
4. ➡️ Proteinuria ➡️ progressive renal insufficiency





💥 HEMODYNAMIC ADAPTATION:

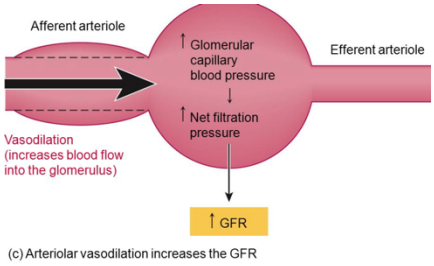
- Intraglomerular hypertension (↑PGC) = compensation (to nephron loss ,, maintain GFR)
- Due to:
  - Afferent vasodilation (↑ BF)
  - Efferent vasoconstriction (↓ blood outflow)
- Fall in GFR is minimized by ↑ P_{GC}
- Response ? ↓ flow to the macula densa (due ↓nephron fx →trigger : activation of TGF)



📐 MEASUREMENT OF GFR:

✅ Common Methods:

- Serum creatinine
- eGFR (MDRD or Cockcroft-Gault)
- Creatinine clearance (± cimetidine)
- Inulin clearance (gold standard) -> research
- Radionuclide markers
- Cystatin C



(c) Arteriolar vasodilation increases the GFR

📌 Ideal GFR Marker Should Be:

- Constantly produced
- Safe and convenient
- Rapidly diffusable in ECF
- Not protein-bound , freely filterable
- Not reabsorbed or secreted
- No extrarenal elimination or degredation
- Minimal interference with other compounds
- Cheap and accurate

🧱 EQUATIONS:

🧠 **Cockcroft-Gault**

🧠 **MDRD**:

🔬 CYSTATIN C:

- 13 kDa protein made by all nucleated cells

- expensive
- Constantly produced
- Filtered by glomerulus
- Metabolized in PCT
- **Unaffected** by muscle mass or diet
- Still investigational

🩺 CKD INVESTIGATION:

- Urinalysis → proteinuria, hematuria, RBC casts <active urine>
- US → kidney size (small = chronic) // large = AKI , polycystic
- Hb, mineral metabolism (check for anemia , common in CKD due to ↓EPO production)
- Past Cr values
- Follow – up serum cr

📌 Who Should Get a Biopsy?

- Young > Old (HEREDITARY NEPHRITIS, FABRY ETC.)
- Early > Late
- Hematuria > bland urine
- Heavy proteinuria > none
- Normal kidney size > small
- No clear etiology > DM/HTN/ vascular disease

⚠️ FACTORS THAT ACCELERATE CKD:

- Hypertension
- Proteinuria
- Hyperlipidemia
- High dietary protein
- Angiotensin II / Aldosterone
- Metabolic acidosis
- Hyperphosphatemia
- Hyperuricemia

⚕ GENERAL CKD MANAGEMENT:

1. Treat reversible causes
2. Prevent / slowing progression
3. Treat complications
4. Educate and prepare for RRT

📉 HOW TO SLOW PROGRESSION:

- ↓ Proteinuria (goal <0.5–1 g/day) (PCR < 60)
    - Start ACEi or ARB (combine if needed)
    - SE for combination ? AKI / hyperkalemia
- ↓ BP (target <130/80)
    - Start ACEi or ARB
    - Add diuretic or other meds if needed
- ↓ Dietary protein (0.8–1 g/kg/day)
- Manage lipids, metabolic acidosis (HCO3 = 22)
- STOP smoking 🚭

⚠️ CKD COMPLICATIONS:

🫀 Volume overload

- Na restriction, diuretics

🧪 Hyperkalemia
- Low K diet, diuretics, Kayexalate (→ bowel perforation → ischemia)

🥴 Acidosis
- HCO3 goal = 22 mmol/L
- NaHCO3 (0.5–1g PO BID–TID) // ps: don't initiate before controlling na + BP

🦴 Hyperphosphatemia
- Stage 3 CKD onward
- Target PO4 = 0.87–1.49 mmol/L
- Low diet
- PO4 binders: CaCO3, Sevelamer

🧬 renal osteadystrophy
- ↑PTH from Stage 2–3 CKD
- Target depends on GFR → Avoid oversuppression (→ adynamic bone disease)
- Vit D3 drops with stage 3
- Calcitriol 0.25 mcg/day
- PO4 binders: CaCO3, Sevelamer

🩸 Anemia
- Stage 3 CKD (common)
- Exclude non renal causes
- Treat with EPO + iron

🩺 HTN
- Target <130/80
- ACEi/ARB ± loop, non-dihydropyridine CCB

Why early referral is important:
- Helps choose the right **dialysis method** 🧃
- Allows time to place **proper dialysis access** (like a fistula) 🪡
- Dialysis can start **calmly, not in an emergency** 🚫🆘
- **Fewer complications** and better recovery 🧠💪
- **Shorter and fewer hospital stays** 🏥
- **Lower healthcare costs** 💰
- **Better survival rates** ❤️‍🩹

💡 Bottom line: Early referral = smoother treatment, healthier patient, happier kidneys.

📞 WHEN TO REFER TO NEPHROLOGY:
- AKI
- eGFR <30
- Rapid decline in function
- Proteinuria >500 mg/day (PCR >60) // PRESENT ON 2 OF 3 SAMPLES
- BP not at target
- Unable to use renoprotective meds
- Education for dialysis/transplant

⚠️ Late Referral = seen within 1–6 months before needing RRT (bad outcomes!)

📅 PREP FOR DIALYSIS: Start at **Stage 4 CKD (eGFR ≤30)**
- Begin 1 year before expected start
- Educate about modalities (PD, HD, transplant)
- Promote autonomy & home options

📌 Access Placement:
- HD: AV fistula ~3 months before

- PD: PD catheter ~1 week before

⏳ WHEN TO INITIATE DIALYSIS:

- Refractory volume overload
- Hyperkalemia (K >6) not controlled by meds(keyexalate) /diet
- Uremia signs (e.g., pericarditis, confusion)
- Metabolic Acidosis unresponsive to NaHCO3
- Not based only on eGFR!

💡 STAGE 5 OPTIONS:

- Pre-emptive living donor transplant
- Home options:
  - Peritoneal dialysis
  - Nocturnal home HD
- In-center HD
- Self-care

🩸 HEMODIALYSIS:

- Conventional: 4h, 3x/week
- Short daily: 2–3h, 4–6x/week
- Nocturnal: 6–8h, 3–6x/week

🔌 Access:

- AV fistula (best)
- AV graft
- Internal jugular cuffed catheter (temp) → UC cath

💧 PERITONEAL DIALYSIS:

- CAPD: 4–5 manual exchanges daily 2-2.5L/D
- CCPD: Automated overnight + daytime dwell