10 INTERPRETATION OF KIDNEY FUNCTION TEST & URINE ANALYSIS

1. **Describe the filtration and reabsorption of urea in the kidneys?**
   - Urea is freely filtered by the glomerulus.
   - Approximately 50% of filtered urea is reabsorbed in the **proximal convoluted tubule (PCT)** alongside water reabsorption.
   - Urea is secreted in the **thin ascending limb of the loop of Henle (TALH)**.
   - In the **collecting duct**, urea is reabsorbed with water, contributing to a high osmolar urea gradient in the renal medulla essential for urine concentration.
2. **List the two primary physiological functions of urea?**
   1. Detoxification of ammonia.
   2. Water conservation.
3. **List the causes of increased plasma or serum urea concentration?**
   1. Renal disease or failure, such as AKI or CKD.
   2. Dehydration.
   3. Decreased renal perfusion caused by heart failure, hypovolemic shock, or severe hypotension.
   4. Gastrointestinal bleeding.
   5. High-protein diet.
   6. Catabolic states, including trauma, severe infection, starvation, or use of corticosteroid drugs.
4. **List the causes of decreased plasma or serum urea concentration?**
   1. Pregnancy.
   2. Low-protein diet.
   3. Overhydration.
   4. Advanced liver disease, such as cirrhosis or liver failure.
   5. Inherited defects in "urea cycle" enzymes that reduce urea synthesis.
5. **Why is creatinine a preferred marker for renal function compared to BUN?**
   - Creatinine is less affected by dietary intake.
   - It is freely filtered by the glomerulus and is not reabsorbed.
   - Plasma creatinine concentration remains constant as long as the patient's muscle mass is unchanged.
6. **Explain how age, sex, and race influence serum creatinine levels?**
   1. **Older age:** Levels decrease due to an age-related decline in muscle mass, leading to reduced creatinine generation.
   2. **Female sex:** Levels are lower because females generally have reduced muscle mass compared to males.
   3. **Race:** African Americans typically have higher levels due to a higher average muscle mass compared to Caucasians.

7. Identify the three presentation patterns of an increased urea-creatinine ratio?

1. Increased plasma urea with normal plasma creatinine.
2. Normal plasma urea with decreased plasma creatinine.
3. An increase in plasma urea that is disproportionately greater than the increase in creatinine.

8. List the causes of a lower than normal urea-creatinine ratio?

1. Low protein intake.
2. Advanced liver disease.
3. Sickle cell anemia.
4. Hypothyroidism.
5. Rhabdomyolysis.
6. Use of drugs like acetazolamide.

9. Define Glomerular Filtration Rate (GFR)?

- GFR is the amount of plasma filtered through the glomeruli per unit of time.

10. List the criteria for an ideal filtration marker?

④ It must be freely filtered at the glomerulus.
⑤ It must be present at a stable plasma concentration.
⑥ It must not be reabsorbed, secreted, or metabolized by the kidney.

11. Compare urea and creatinine as markers of GFR?

Criteria	Urea	Creatinine
Excretion route	Mostly kidneys, but <10% via sweat and feces.	Primarily the kidneys; non-renal routes only in advanced disease.
Glomerular filtration	Freely filtered.	Freely filtered.
Tubular handling	Reabsorbed (40-50% appears in urine) and secreted.	Not reabsorbed; virtually all filtered appears in urine, though a small amount is secreted.
Non-renal influences	Materially affected by diet and other non-renal factors.	Constant if muscle mass is stable; gender and ethnically dependent.

12. State the Indications for measuring GFR instead of using estimation equations?

1. Extremes of age and body size.
2. Severe malnutrition or obesity.
3. Diseases of skeletal muscle.
4. Paraplegia or quadriplegia.
5. Vegetarian diet.
6. Rapidly changing kidney function.
7. Pregnancy.

13. Define proteinuria and its normal excretion values?

- Proteinuria is defined as a high amount of protein in the urine, exceeding 150 mg/day.

- Normal excretion is <150 mg/day in adults and <140 mg/m²/day in children.

14. Classify the grades of proteinuria based on daily protein excretion?

1. **Microalbuminuria:** 30–300 mg/day of albumin.
2. **Mild:** <1000 mg/day.
3. **Moderate:** 1000–2000 mg/day.
4. **Heavy:** >2000 mg/day.
5. **Nephrotic range:** >3500 mg/day.

15. Identify the causes of false-positive results on urine dipsticks for protein?

- High urine specific gravity (≥1.030).
- Highly alkaline urine (pH >8.0).

16. Compare 24-hour urine protein excretion and the random protein-creatinine ratio?

Feature	24-Hour Urine Collection	Random Protein-Creatinine Ratio
Status	Reference (gold-standard) method.	Recommended alternative.
Accuracy	Most accurate for monitoring during treatment; averages circadian rhythm.	Reduces pre-analytic errors; not influenced by water intake or diuresis.
Practicality	Can be impractical for elderly or outpatients; requires detailed instructions.	Easy to obtain; same sample can be used for microscopy.

17. Describe transient proteinuria and its causes?

- **Transient proteinuria** involves temporary changes in glomerular hemodynamics that increase protein excretion.
- It is usually benign and self-limited.
- **Examples** include congestive heart failure, fevers, strenuous exercise, seizure disorders, extreme stress, and orthostatic proteinuria.

18. Outline the proper procedure for collecting a urine specimen for analysis?

- The first 200 ml of early-morning voided urine should be discarded.
- For men, a simple midstream collection is sufficient.
- For women, external genitalia should be cleaned first, followed by midstream collection to avoid contamination.
- The specimen should be collected in a clean container and analyzed within 30 to 60 minutes of voiding.

19. Differentiate between persistent glomerular, tubular, and overflow proteinuria?

Type	Mechanism	Protein Characteristics	Examples
Glomerular	Increased filtration of albumin across glomerular walls.	Large macromolecular proteins (mainly albumin); mild to heavy.	Diabetic nephropathy.
Tubular	Defective reabsorptive capacity in the proximal tubule.	Low molecular weight proteins; almost always mild (<2 g/day).	Tubulointerstitial diseases.
Overflow	Overproduction of Ig light chains exceeding tubular threshold.	Bence Jones proteins (monoclonal light/heavy chains).	Multiple myeloma.

20. Match abnormal urine colors with their potential causes?

1. **Red:** Beets, blackberries, laxatives, lead, mercury, or urinary tract infections.
2. **Orange:** Vitamin C, carrots, rifampin, or phenazopyridine.
3. **Green:** Asparagus, vitamin B, or Pseudomonas infection.
4. **Black:** Malignant melanoma, porphyria, or alkaptonuria.
5. **White:** Crystals, leukocytes, or chyluria (lipids).

21. Interpret different urine odors and clarities?

1. **Offensive odor:** Suggestive of a urinary tract infection.
2. **Sweet odor:** Suggestive of glycosuria.
3. **Cloudy urine with sediment:** May indicate stones, infection, or nephrotic syndrome.
4. **Frothy urine:** Associated with significant proteinuria.

22. Compare glomerular and nonglomerular hematuria?

Feature	Glomerular Hematuria	Nonglomerular Hematuria
Proteinuria	>500 mg/day.	<500 mg/day.
RBC Casts	Present.	Absent.
RBC Morphology	Dysmorphic RBCs present.	Dysmorphic RBCs absent.
Common Causes	Acute glomerulonephritis.	Tumors, stones, or infections.

23. List the factors that promote the formation of urinary casts?

1. Low urine flow rate.
2. High urinary salt concentration.
3. Low urine pH.
4. Note: All these factors favor protein denaturation and precipitation of the Tamm-Horsfall protein.

24. Associate specific urinary casts with their disease states?

1. **Hyaline casts:** Nonspecific; seen in normal individuals or during volume depletion.
2. **Granular casts:** Acute tubular necrosis (specifically "muddy-brown" casts).
3. **Waxy and broad casts:** Advanced kidney disease.
4. **Red blood cell casts:** Glomerulonephritis.
5. **Fatty casts:** Nephrotic syndrome ("Maltese-cross" appearance).

25. Identify specific urinary crystals and their clinical significance?

1. **Calcium oxalate (envelope-shaped):** Ethylene glycol toxicity.
2. **Uric acid (diamond/barrel-shaped):** Hyperuricosuria.
3. **Triple phosphate (coffin-lid):** UTI caused by urea-splitting organisms like Proteus.
4. **Cystine (hexagonal):** Cystinuria.