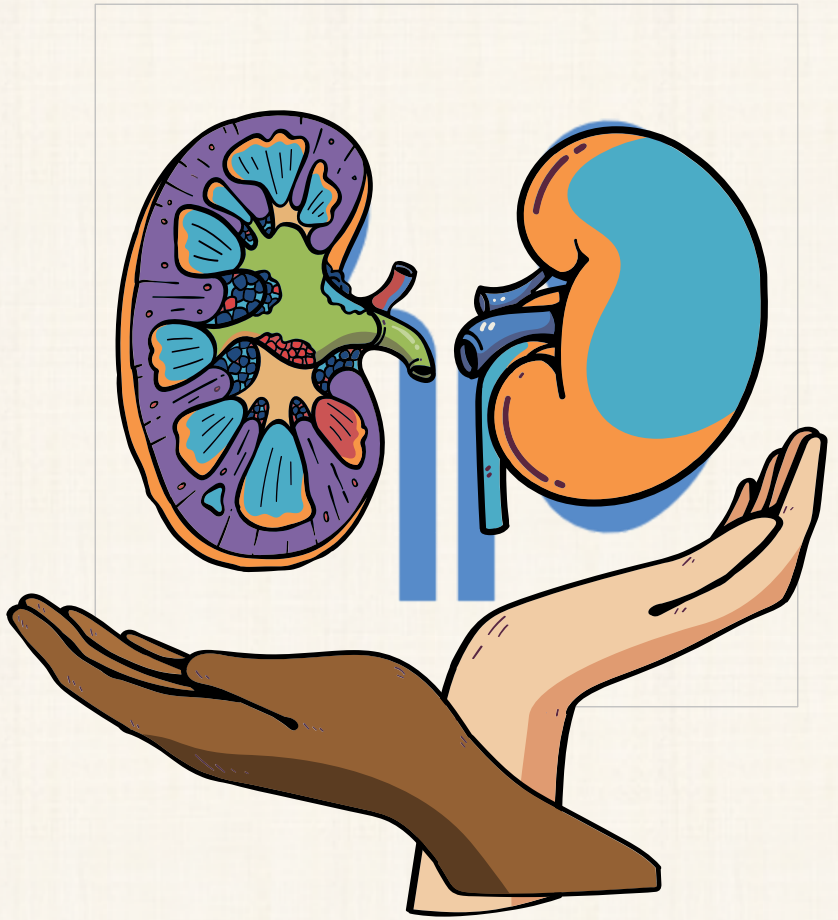
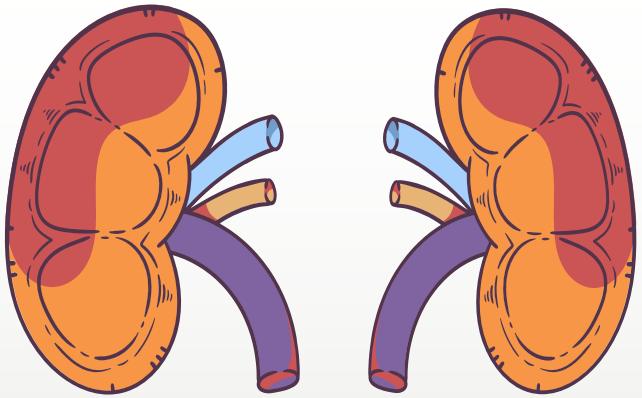
MUE
Merit University

Biochemistry department

RRS-209



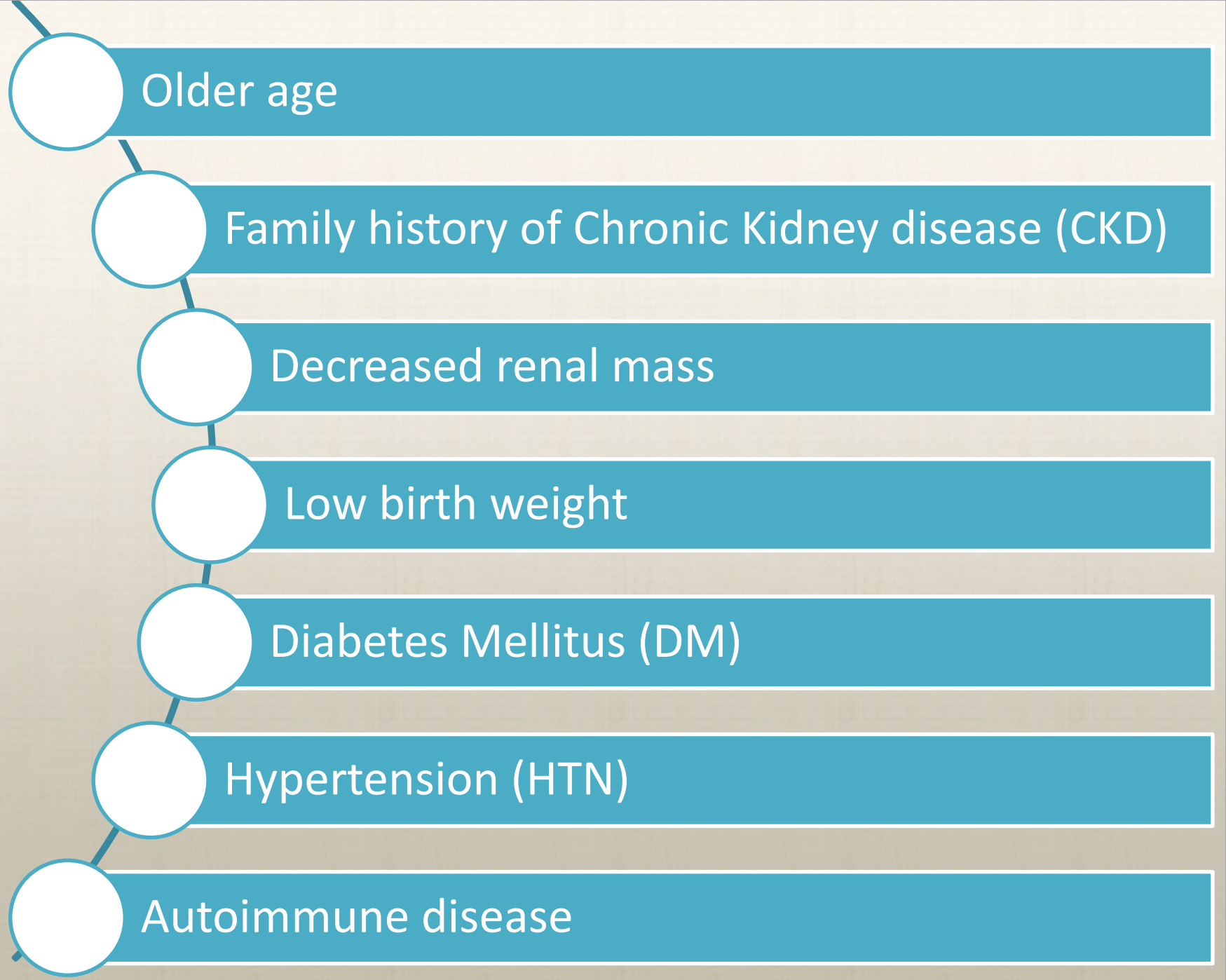
Kidney Stones



Kidney functions :

- Regulation of :
- - Water and electrolyte balance.
- - Acid base balance.
- - Arterial blood pressure.
- Excretion of metabolic waste products and foreign chemicals.
- Hormonal Function: Secretion of erythropoietin & activation of vitamin D and activation of angiotensinogen by renin.
- Metabolic Function: site for gluconeogenesis

When should you assess renal function?



Biochemical Tests of Renal Function

1.Measurement of GFR

- Clearance tests
- Plasma creatinine
- Urea, uric acid and β2-microglobulin

2.Renal tubular function tests

- Osmolality measurements
- Specific proteinurea
- Glycosuria
- Aminoaciduria

3.Urine analysis

- Appearance
- Specific gravity and osmolality
- pH
- osmolality
- Glucose
- Protein
- Urinary sediments

Biochemical Tests of renal function

- In acute and chronic renal failure, there is effectively a loss of function of whole nephrons .
- Filtration is essential to the formation of urine .
- **tests of glomerular function are almost always required in the investigation and management of any patient with renal disease.**
- The **most frequently used tests** are those that assess **either the GFR** or the **integrity of the glomerular filtration barrier**.

2.Renal tubular function tests

- To ensure that important constituents such as water, sodium, glucose and A.A. are not lost from the body, tubular reabsorption must be equally efficient
- Compared with the GFR as an assessment of glomerular function, there are no easily performed tests which measure tubular function in quantitative manner.
- **Investigation of tubular function:**

1. Osmolality measurements in plasma and urine; normal urine: plasma osmolality ratio is usually between **1.0-3.0**
2. Specific proteinuria
3. Glycosuria
4. Aminoaciduria

Urinalysis using disposable strips

DIPSTICK TEST

- ✓ To test a urine sample:
- ✓ fresh urine is collected into a clean dry container
- ✓ the sample is not centrifuged
- ✓ the disposable strip is briefly immersed in the urine specimen;
- ✓ The color of the test areas are compared with those provided on a colour chart

ine sample: (a) Immersion of test strip in urine specimen. (b

Kidney stones

Definition

Kidney stones are small, hard deposits of mineral and acid salt on the inner surfaces of kidneys.

Stone growth starts with the formation of crystals in the supersaturated urine

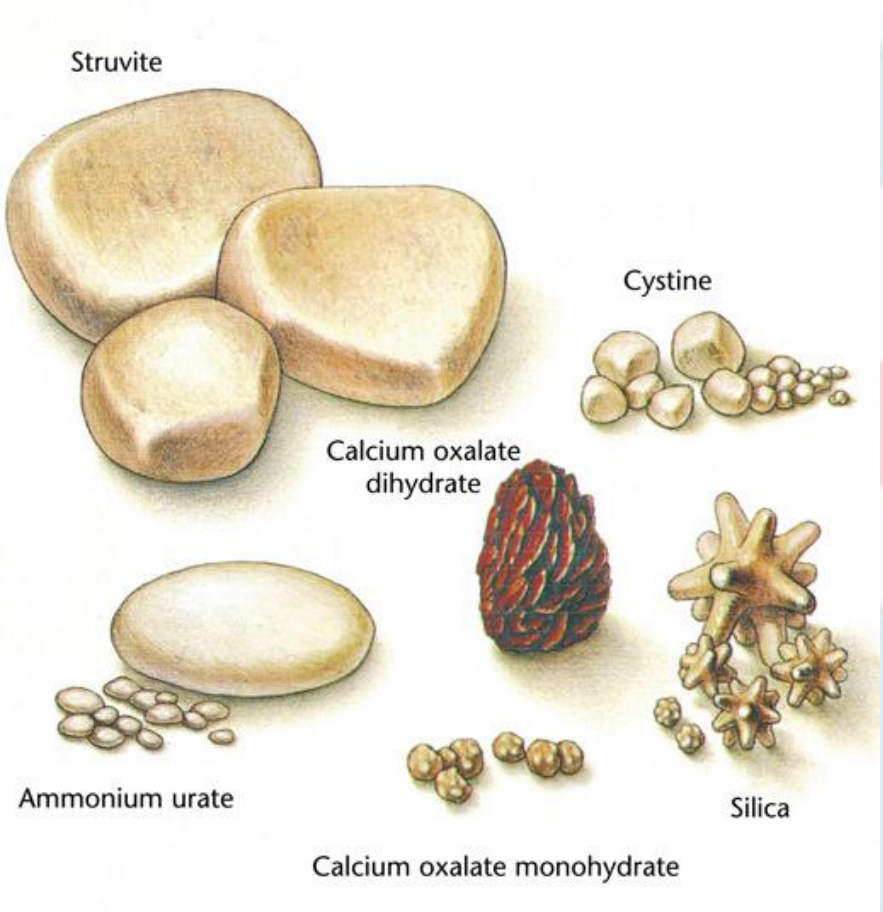
stones are classified by their location in urinary system and their composition of crystals .

types of stones

1. ***Calcium salt stones (80% of kidney stones) .***
2. ***Mg ammonium PO4 stones.***
3. **Cystine stones .**
4. **Uric acid stones.**
5. **Mixed stones.**

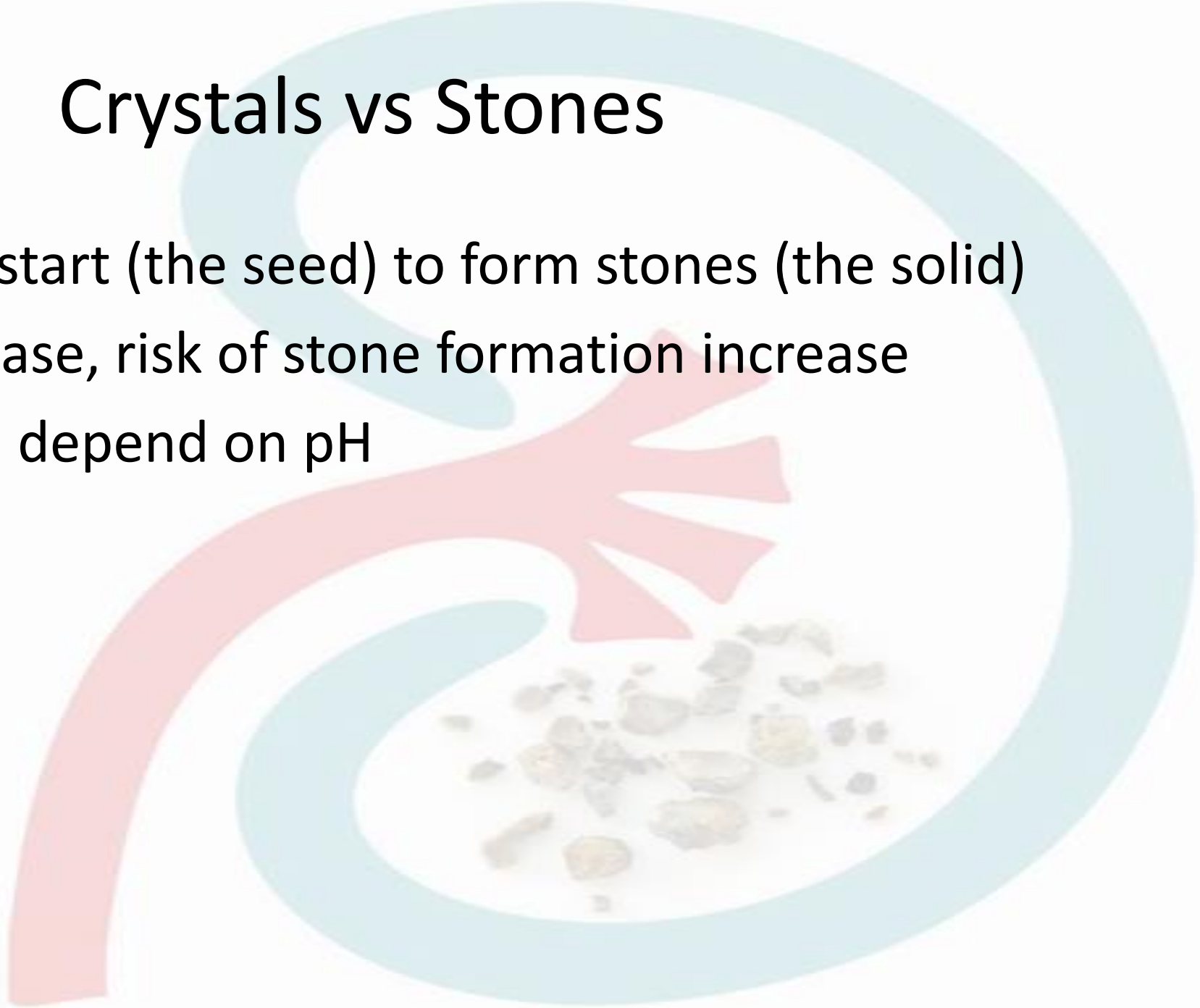
Kidney stones (Renal Calculus)

Urolithiasis / Nephrolithiasis



Crystals vs Stones

- Crystals are the start (the seed) to form stones (the solid)
- As Crystals increase, risk of stone formation increase
- Stone formation depend on pH



↑ URINARY SOLUTES (CALCIUM, URIC ACID, OXALATE AND SODIUM

↓ STONE INHIBITORS (CITRATE AND MAGNESIUM)

↓ URINARY VOLUME

↑ OR ↓ URINARY pH

RISK FACTORS

HIGH PROTIEN

HIGH SALT INTAKE

- ANTACIDS
- CARBONIC ANHYDRASE INHIBITORS
- Na^+ AND Ca^{2+} CONTAINING

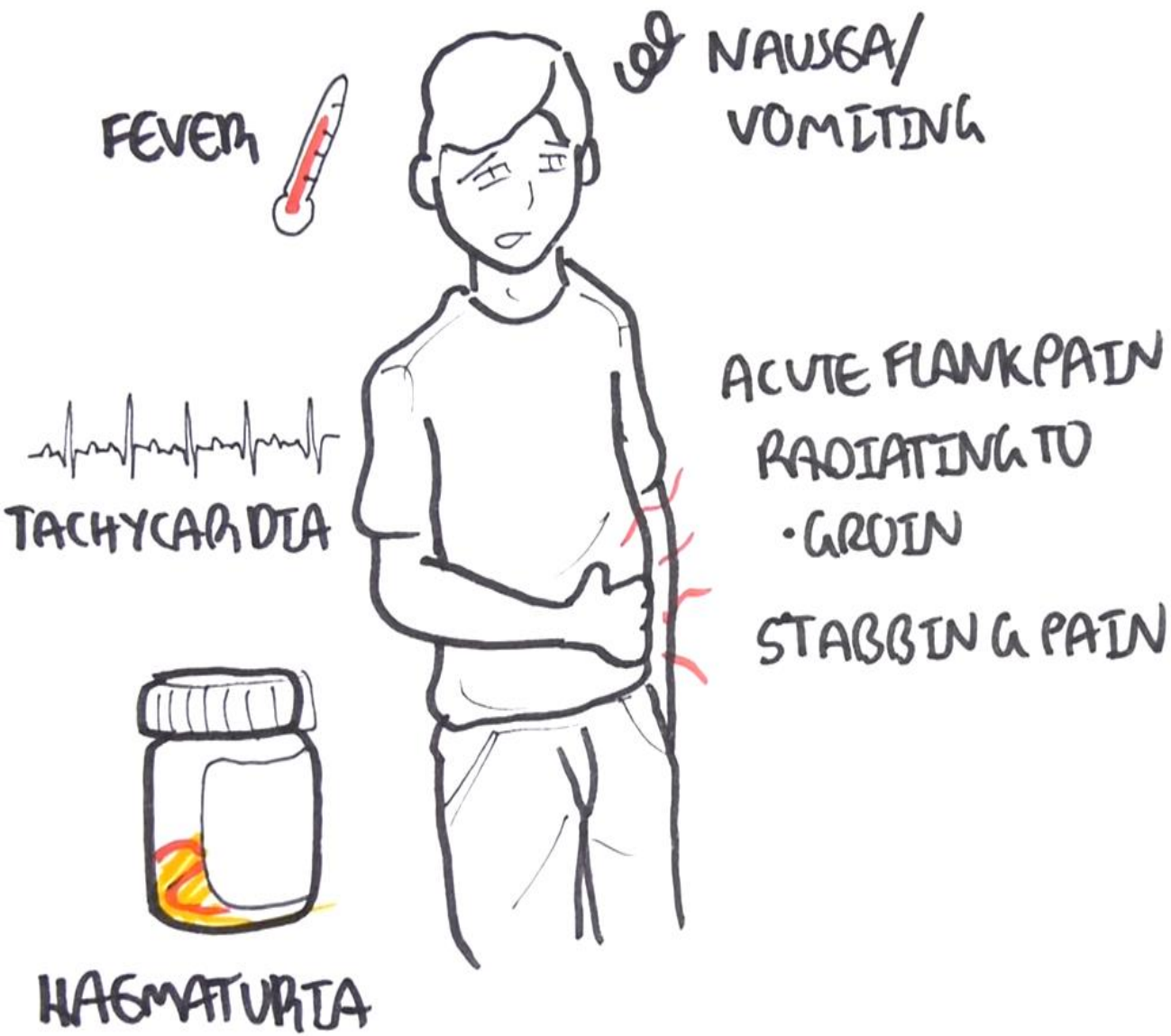
OBESITY

DEHYDRATION

MALE

WHITE

CLINICAL PRESENTATION



ACUTE MANAGEMENT

- ANALGESIA
- ANTIEMETIC
- IV FLUIDS

MOST SMALL STONES (<0.5cm)
PASS SPONTANEOUSLY

How it is formed ?

Conditions leads to kidney stones

1. **High conc. of metabolic products in the filtrate is due to:**
   - Low urinary volume (with normal renal function) due to restricted fluid intake
   - Increased fluid loss from the body
   - Increased excretion of metabolic products forming stones
   - High plasma volume (high filtrate level)
   - Low tubular reabsorption from filtrate

2. Changes in urine pH due to:

- Bacterial infection
- Precipitation of salts at different pH

Factors affect pH include Diet, Time of Day, Physical Exercise

3. Urinary stagnation is due to:

- Obstruction of urinary flow

4. Deficiency of stone-forming inhibitors:

- Citrate, pyrophosphate, glycol-proteins inhibit growth of calcium phosphate and calcium oxalate crystals
- In type I renal tubular acidosis, hypocitraturia leads to renal stones

Laboratory investigations

- ✓ If stone has formed and removed:
  - ❋ Chemical analysis of stone helps to:
    1. Identify the cause
    2. Advise patient on prevention and future recurrence
- ✗ If stone has not formed:
  - ❋ This type of investigation identifies causes that may contribute to stone formation

Tests are performed for this purpose:

1. Blood chemistry

2. Serum

Calcium, Phosphate. Uric acid. Alkaline phosphates. sodium potassium chloride. Magnesium. Creatinine.

3. Urinalysis

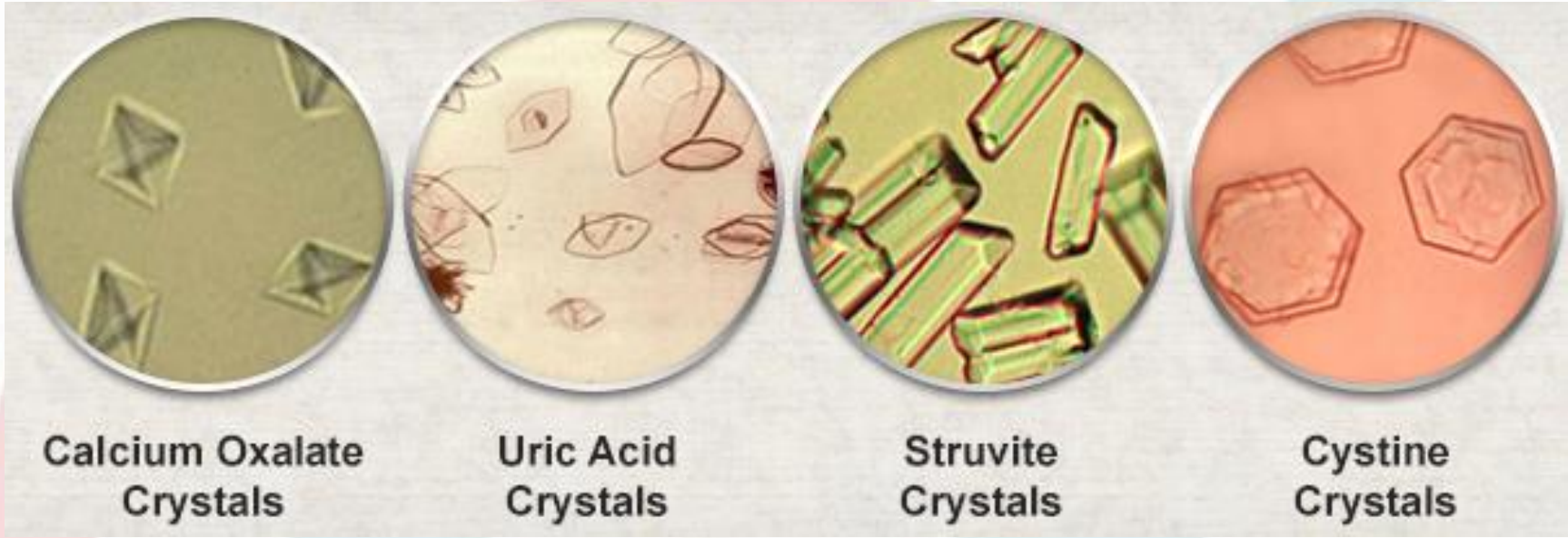
- Volume, calcium, oxalates and cystine levels
- Urine pH > 8 suggests urinary tract infection (Mg amm. PO4)

Microscopy of urine

Urine examination is recommended on a freshly voided morning sample using dip stick test and microscopic examination and culture.

Microscopy may reveal the following crystals:

- Oxalate (envelope)
- Calcium phosphate (amorphous)
- Triple phosphate (coffin lid)
- Uric acid (needle shaped) and
- Cystine (hexagonal)
- As well as any other formed elements



Ca^{++} kidney stones

The # 1 most common kidney stones

Ca^{++} oxalate (acidic environment)

more common

Medicosis

less common

Ca^{++} phosphate (alkaline environment)

- All kidney stones form in an acidic urine **EXCEPT** for kidney stones that have the word "phosphate" in them → alkaline urine

  - Calcium phosphate
    - Calcium carbonate
  - Ammonium-magnesium-phosphate (AMP)
    - STRUVITE stones

Medicosis

- All kidney stones are radio-opaque (visible on X-ray / CT) **EXCEPT** Urate stones: radio-lUcent.

  (**NOT** visible on X-ray / CT)

  ↓

  Try Ultrasound

URINARY Stones [Nephrolithiasis]

#1 MC

Calcium oxalate

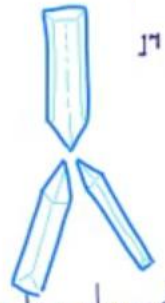
Envelope

@ Acidic urine

Calcium phosphate

Dairy-products rich diet.

↑ Hyperparathyroidism "PTH"



Wedge-shaped prism

@ Alkaline urine

Calcium Carbonate

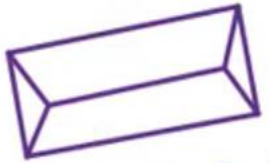
Triple-phosphate

Ammonium-magnesium-phosphate (AMP)

Staghorn

Urine smells like Ammonia

Struvite



Coffin lid

@ Alkaline urine

Medicosis

Uric acid

radio-lUcent

@ Acidic urine

Cystinuria/ Cystinosis

Cystine

@ Acidic urine