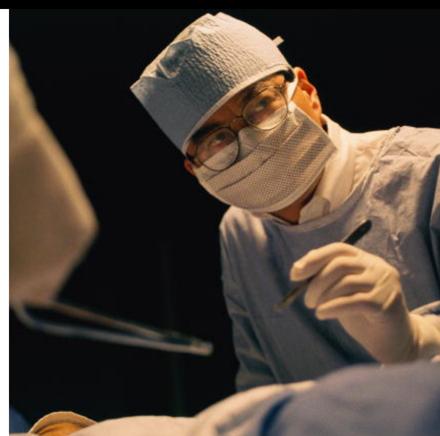
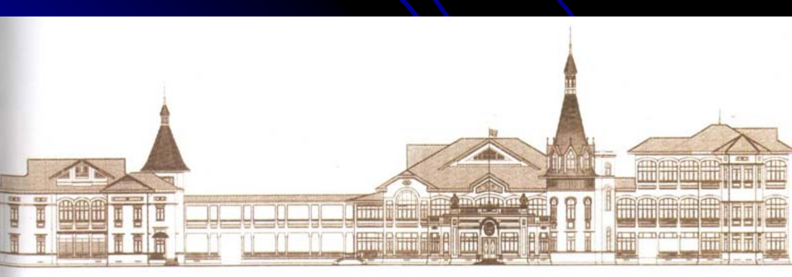
Acid Base Disturbance





ภูษิต เฟื่องฟู พบ.

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กองศัลยกรรม โรงพยาบาลพระมงกุฎเกล้า

Overview

- Body Buffer System
- Acid Base disturbances
- Treatment

Definition

- Acids release H^+
  - example: $HCl \rightarrow H^+ + Cl^-$
- Bases absorb H^+
  - example: $HCO_3^- + H^+ \rightarrow H_2CO_3$

Introduction

- Metabolism generates Hydrogen ions 40-80 mmol/day
- pH 7.35-7.46 retained H^+ within 35-45 nmol/l

H^+ per day = 40-80 x 1,000,000 <u>nmol/l</u>

pH is logarithmic

- $pH = \log 1/[H^+]$

  $= -\log [H^+]$

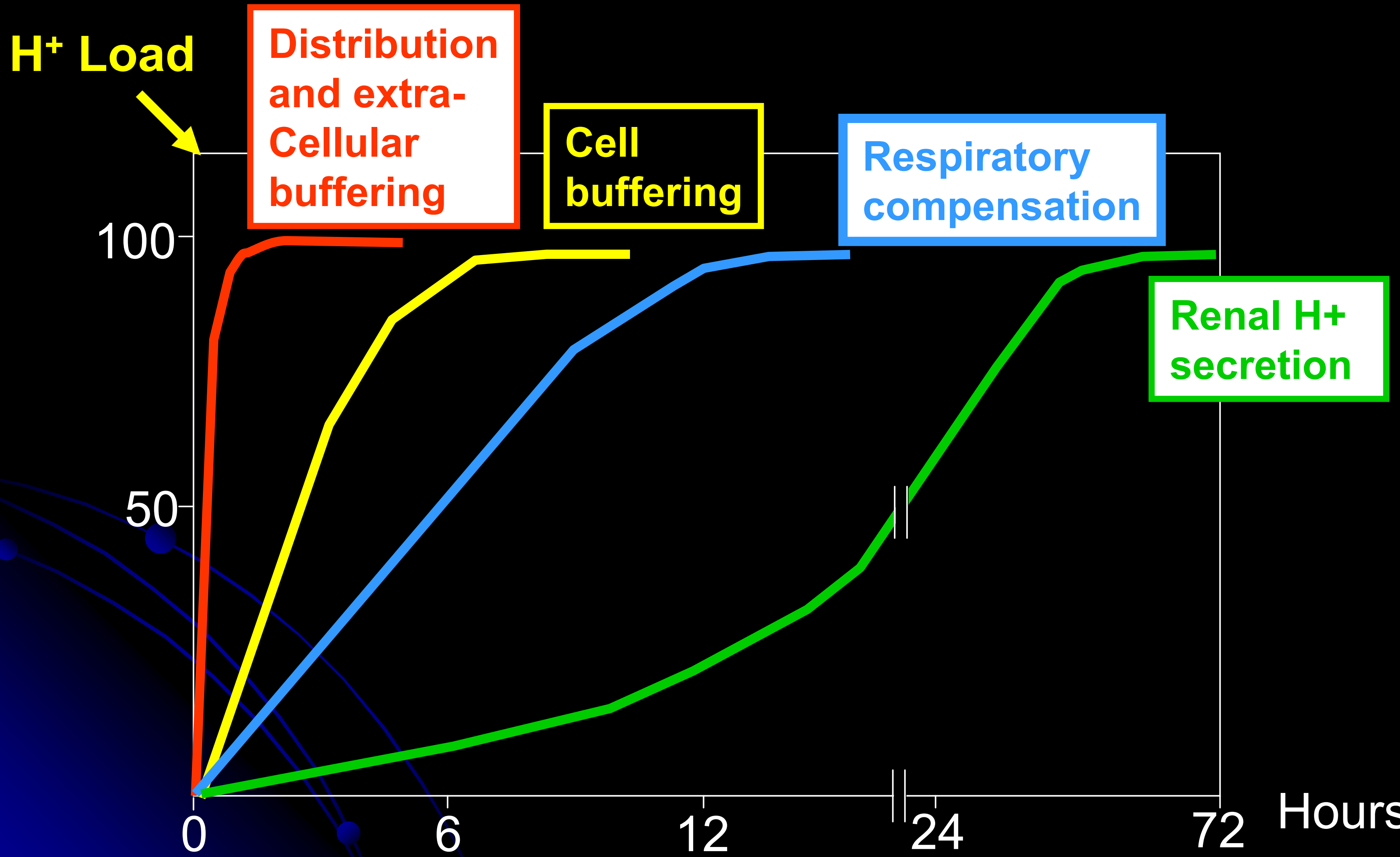
  $= -\log 0.00000004$ Eq/L

  pH = 7.4

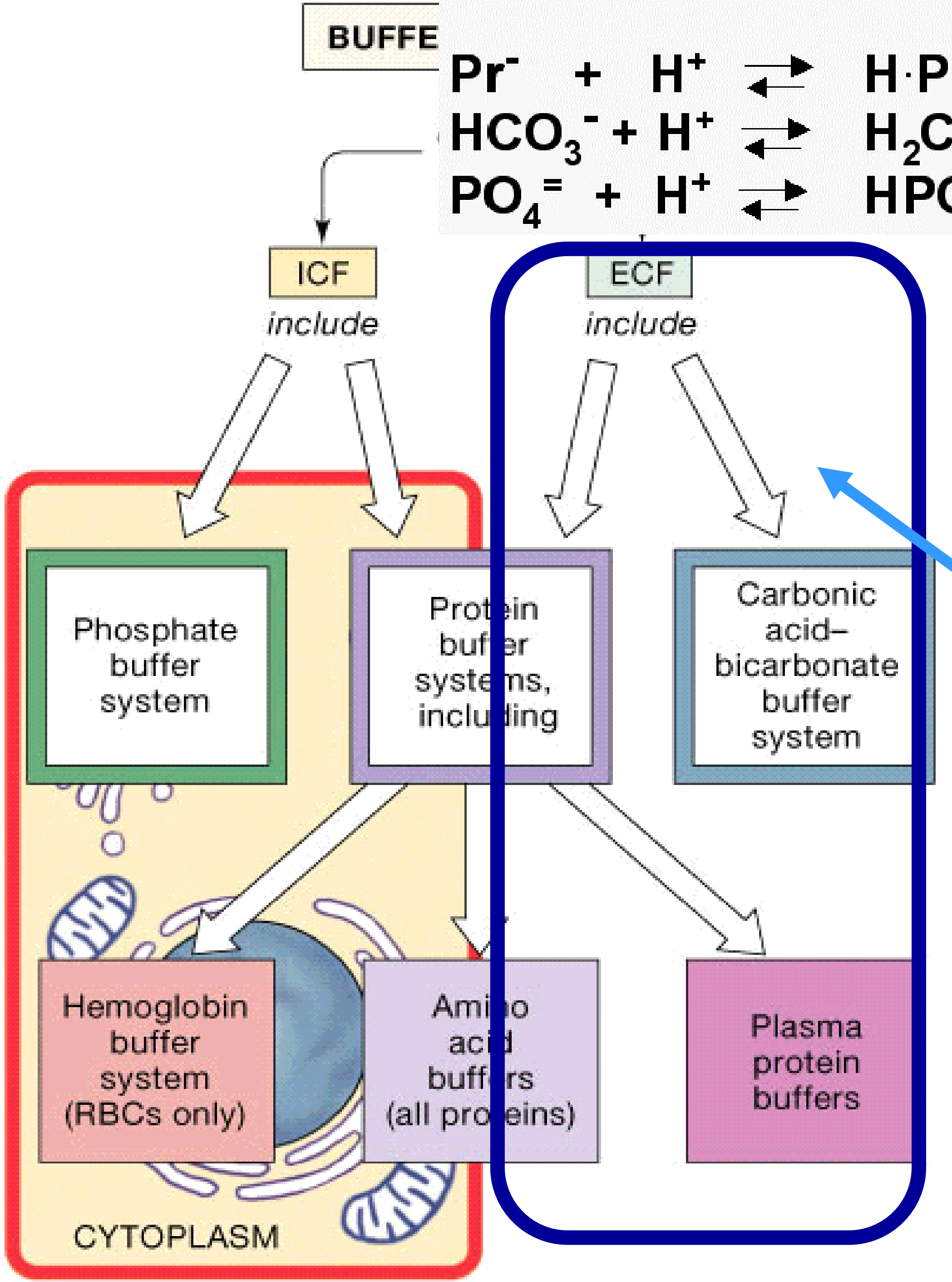
Small Δ pH means large Δ $[H^+]$

pH 7.4 = 0.0000000<u>4</u>
pH 7.1 = 0.0000000<u>8</u>

Buffer: pH Guardian



	% bufferin
$Pr^- + H^+ \rightleftharpoons H \cdot Pr$	1%
$HCO_3^- + H^+ \rightleftharpoons H_2CO_3 \rightleftharpoons H_2O + CO_2$	42%
$PO_4^= + H^+ \rightleftharpoons HPO_4^-$	<1%



The ECF accounted for ~43% of total buffering

Carbonic acid-Bicarbonate Buffer System

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons HCO_3^- + H^+$$

CO_2 Production ↑ (to CO_2)

14,000-20,000 mM/day

Dietary protein breakdown ↑ (to H^+)

40-80 mEq/day

$$[H^+] = 24 \times \frac{pCO_2}{[HCO_3^-]}$$

40 nEq/L → $[H^+]$

40 mmHg → pCO_2

24 mEq/L → $[HCO_3^-]$

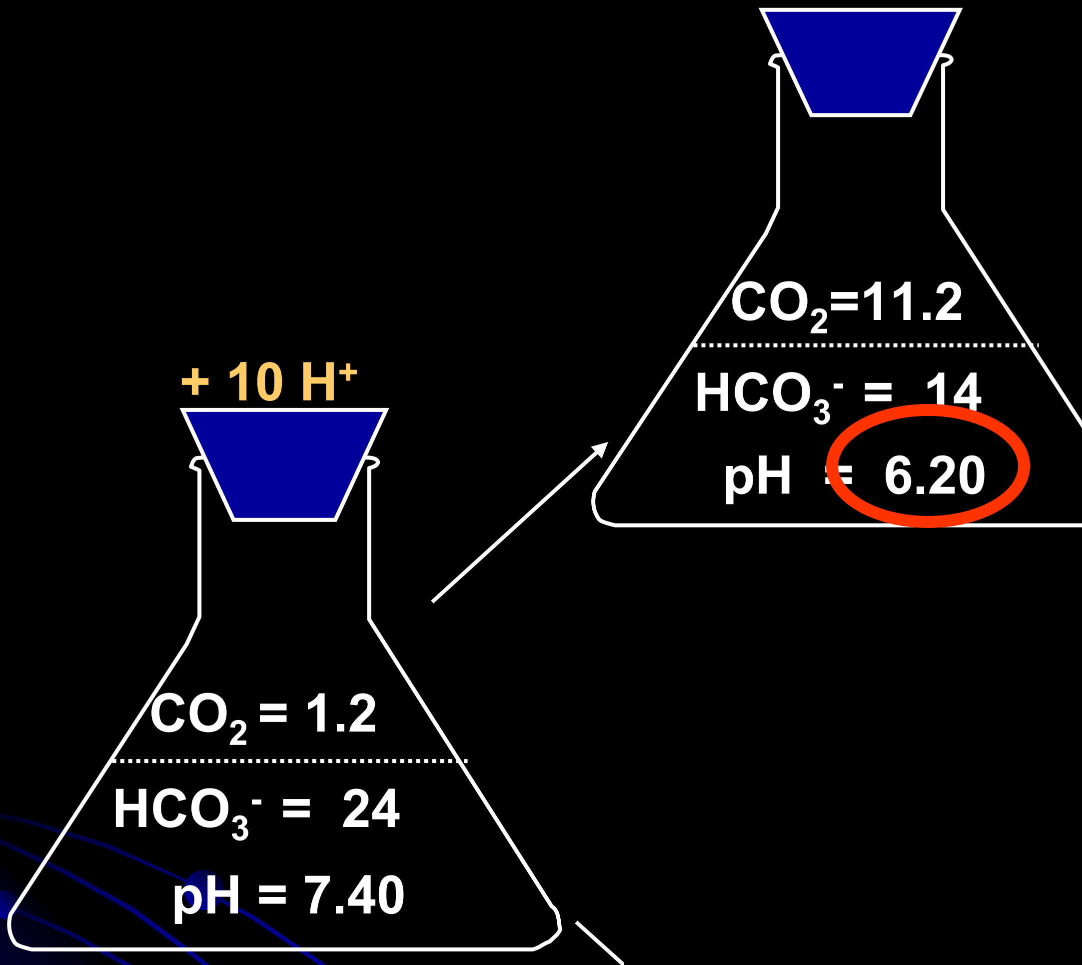
$$[H^+] = 24 \times \frac{pCO_2}{[HCO_3^-]}$$

40 mmHg (→ pCO_2)

40 nEq/L (→ $[H^+]$)

24 mEq/L (→ $[HCO_3^-]$)

estimated[H+]	*pH*
70	7.10
60	7.20
50	7.30
40	7.40
30	7.50



estimated[H+]	*pH*
70	7.10
60	7.20
50	7.30
40	7.40
30	7.50

Henderson-Hasselbach Equation

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons HCO_3^- + H^+$$

$$pH = pK + \log \frac{[A^-]}{[HA]}$$

$[HA] = [H_2CO_3]$ (at equilibrium) $= [CO_2]_{dissolved}$

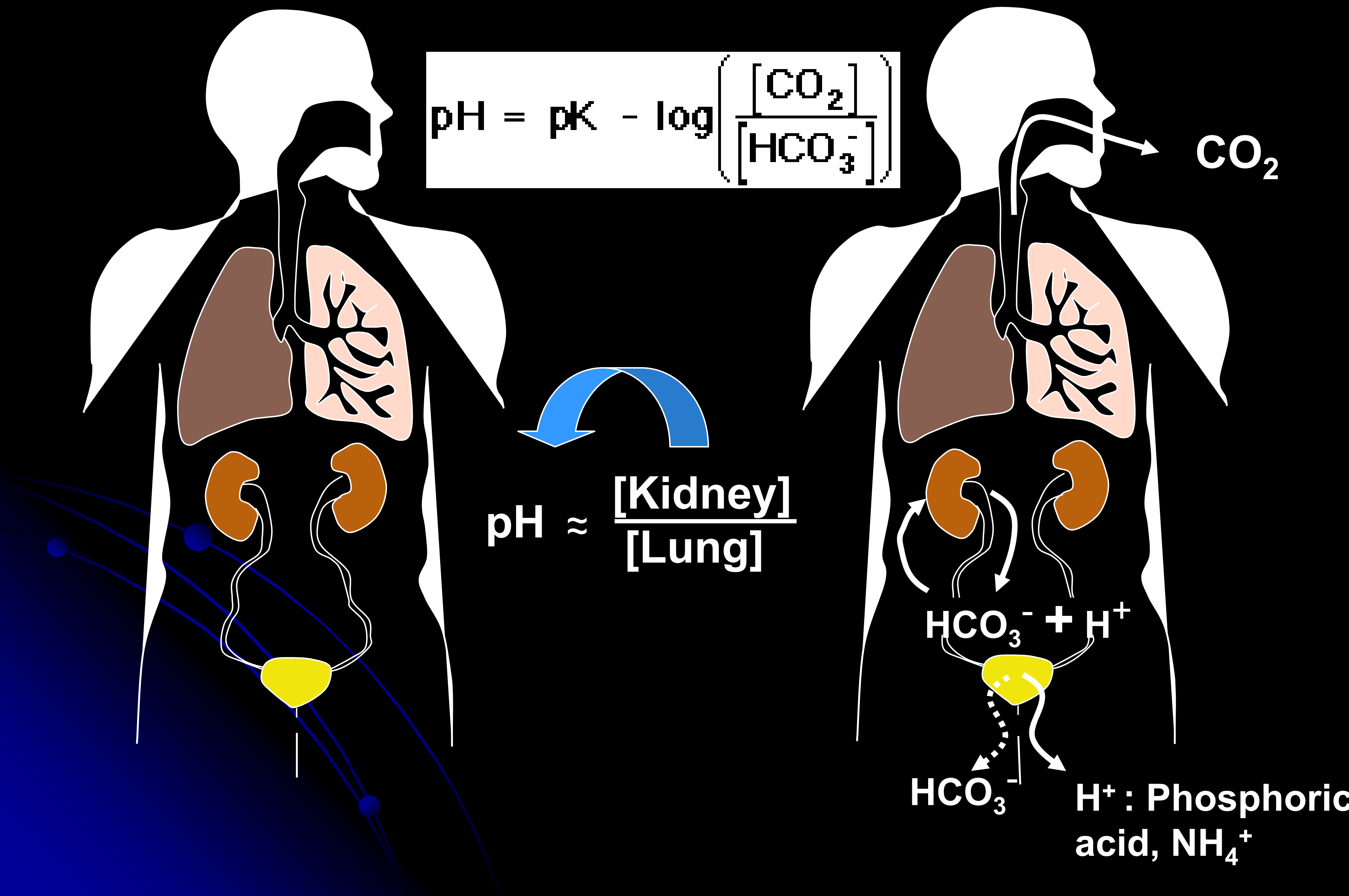
$$pH = 6.1 + \log \frac{[HCO_3^-]}{[CO_2]_{dissolved}}$$

$S_{CO_2} = 0.03$ mmoles CO_2/L/mmHg

$$pH = 6.1 + \log \frac{[HCO_3^-]}{S_{CO_2} \times PCO_2}$$

$$pH = 6.1 + \log \frac{[HCO_3^-]}{0.03 \times PCO_2}$$

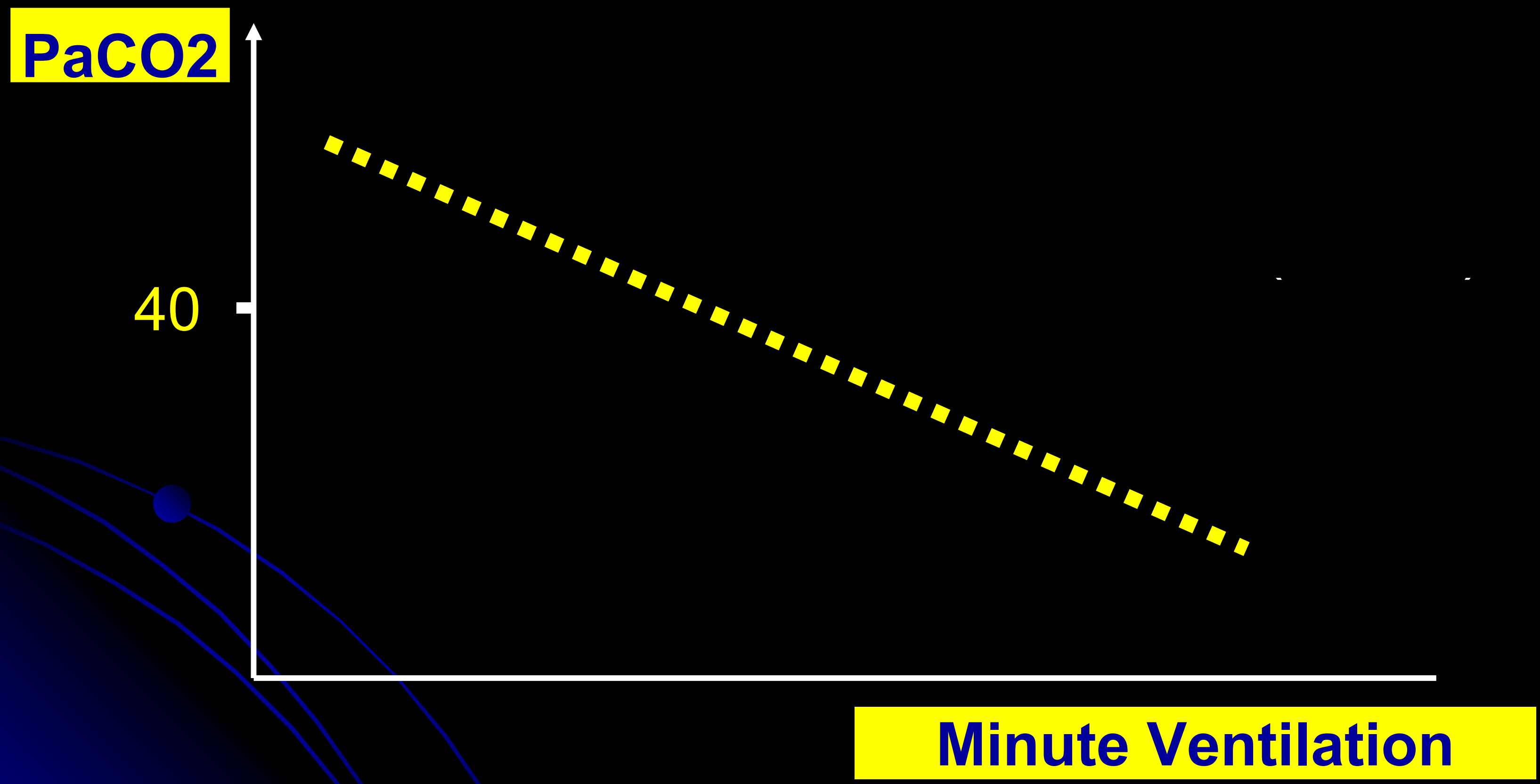
$$pH = pK + \log \frac{\text{Kidneys}}{\text{Lungs}}$$



$pH = pK - \log\left(\frac{[CO_2]}{[HCO_3^-]}\right)$
CO_2
$pH \approx \frac{[Kidney]}{[Lung]}$
$HCO_3^- + H^+$
HCO_3^-
H^+ : Phosphoric acid, NH_4^+

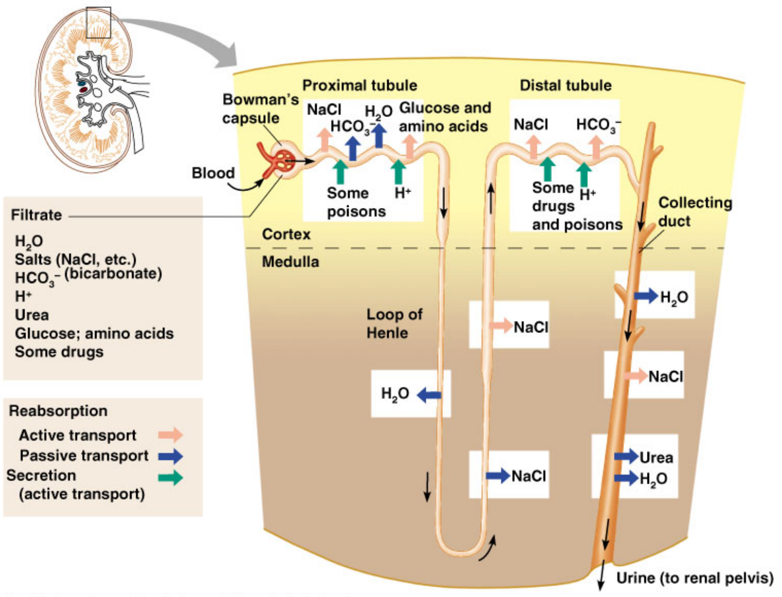
Respiratory Component

PaCO$_2$ & Minute Ventilation



$$\uparrow H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow CO_2 + H_2O$$

Renal Component

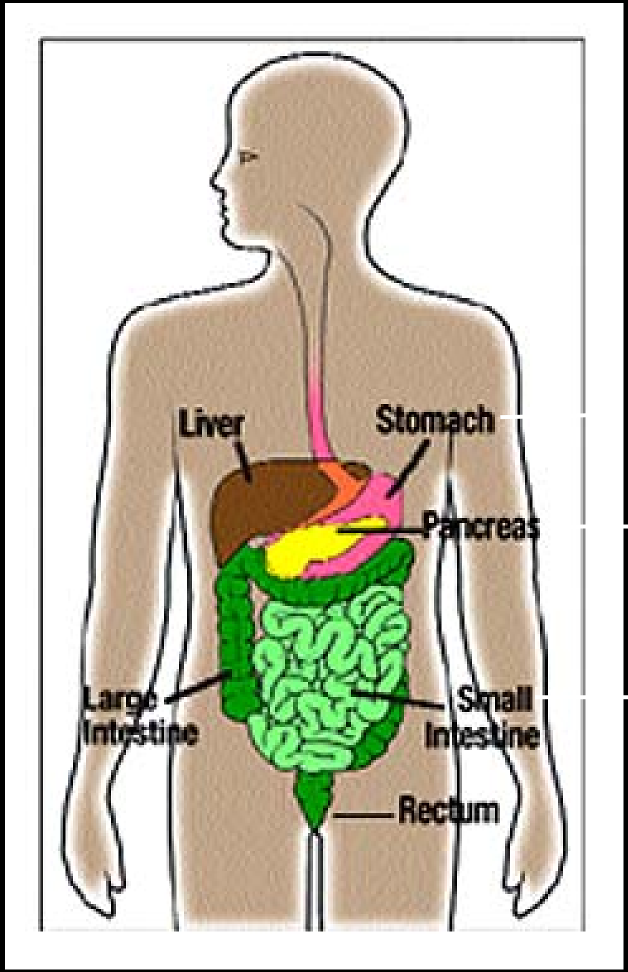


- Production of "new" bicarbonate via excretion of acid ≈ 70 mEq/day
- Reabsorption of filtered bicarbonate ≈ 4,000 mEq/day

Acid-base disturbances from Gastrointestinal loss

Vomiting:
Loss of H^+ leading to alkalosis

Diarrhea:
Loss of HCO_3^- leading to acidosis

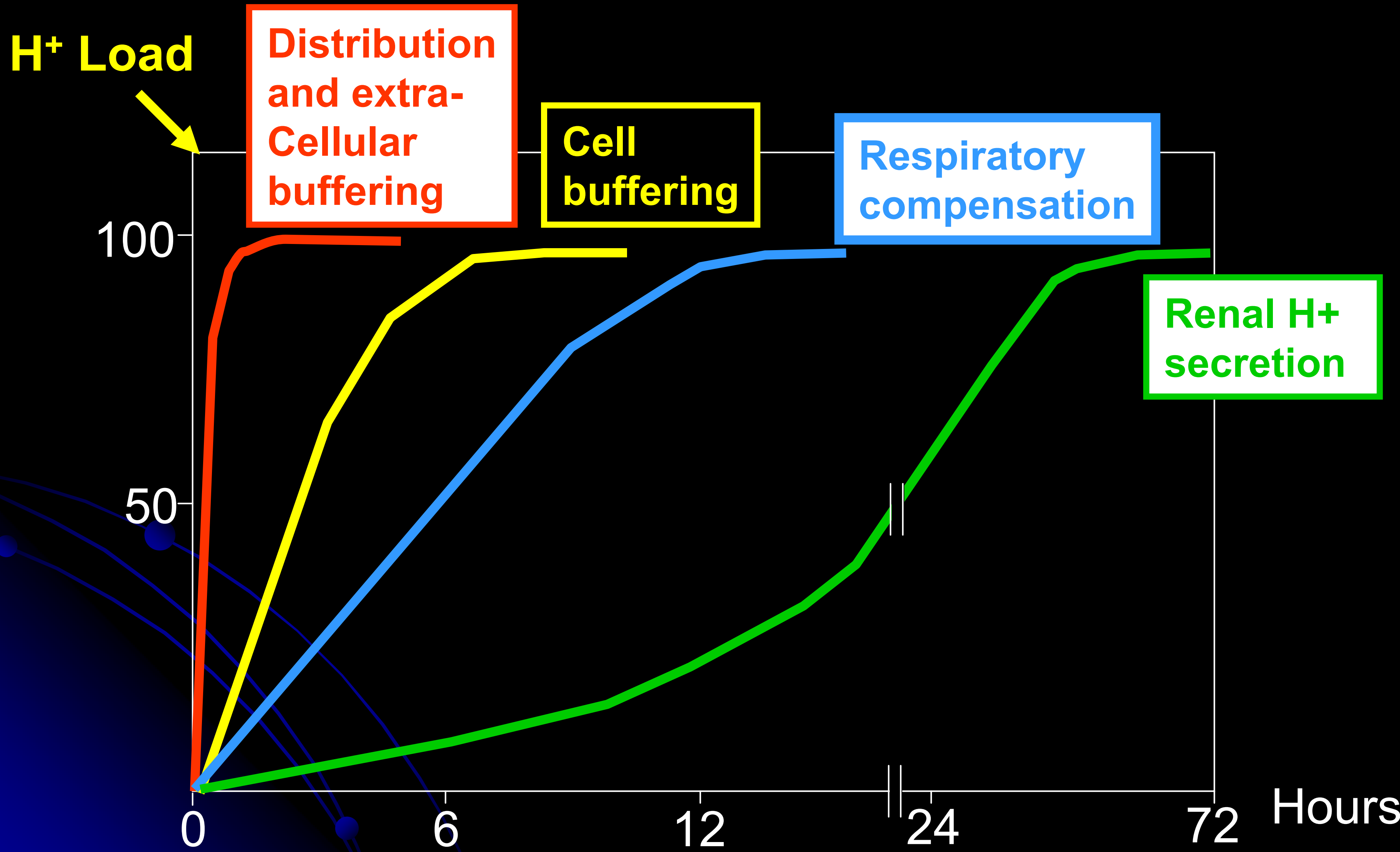


Highly acidic, pH =1.0

Secretes HCO_3^-

pH varies from 4.0 to 8.0

The Big 3 of pH Guardian



The Four Cardinal Acid Base Disorders

Disorder	pH	pCO_2	$[HCO_3^-]$
M acidosis	↓	↓	↓
M alkalosis	↑	↑	↑
R acidosis	↓	↑	↑
R alkalosis	↑	↓	↓

Boston approach in Systemic ABG analysis

1. Check arterial pH
2. [HCO_3^-] & $PaCO_2$ analysis
3. Calculate AG
4. Assess delta ratio
5. Check “clues”
6. Assess compensatory responses
7. Formulate acid-base diagnosis

1. Check arterial pH

- pH < 7.4 = acidosis
  pH > 7.4 = alkalosis
- Principle – No over-compensation

Boston approach in Systemic ABG analysis

√ 1. Check arterial pH
2. $[HCO_3^-]$ & $PaCO_2$ analysis
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2. [HCO_3^-] & $PaCO_2$ analysis

Respiratory Compensation for Metabolic Changes

- Metabolic acidosis

$PaCO_2$ decreases by 1.2 x the drop in $[HCO_3^-]$

$PaCO_2 \approx 1.5\ [HCO_3^-] + 8$

- Metabolic alkalosis

$PaCO_2$ increases by 0.7 x the rise in $[HCO_3^-]$

$PaCO_2 \approx 0.9\ [HCO_3^-] + 16$

Metabolic Compensation for Respiratory Changes

- Respiratory Acidosis

Acute: $[HCO_3^-]$ increases by 0.1 x the rise in $PaCO_2$

Chronic: $[HCO_3^-]$ increases by 0.35 x the rise in $PaCO_2$

- Respiratory Alkalosis

Acute: $[HCO_3^-]$ decreases by 0.2 x the fall in $PaCO_2$

Chronic: $[HCO_3^-]$ decreases by 0.5 x the fall in $PaCO_2$

$[HCO_3^-]$ & $PaCO_2$ analysis

- Both are low

  The last 2-digit if pH = $PaCO_2$

  metabolic acidosis

  respiratory alkalosis

  Both are high

  metabolic alkalosis

  respiratory acidosis

- Opposite directions $[HCO_3^-]$ & $PaCO_2$

  Mixed disorder **<u>must</u>** be present

- 60-year-old diabetic with a long history of not taking her insulin. She is admitted to the hospital and you receive the following data on her:

pH 7.26, $PaCO_2$ 42, HCO_3^- 17... Metabolic acidosis.

- A 1st year resident was anxious about her basic sciences examination. She felt numbness around her mouth and tingling in her hands and went to the clinic.

pH 7.48, $PaCO_2$ 30, HCO_3^- 23… **Respiratory alkalosis**

A 1st year medical student who did really well on his 1st biochemistry test celebrated too much afterwards. After a weekend of atonement, his lab values are:

pH 7.48, $PaCO_2$ 51, HCO_3^- 29… **Metabolic alkalosis**

A 40 year-old man with renal failure for 1 year presents with nausea, vomiting and weakness. His blood chemistry reveals

Na 138 mEq/L, K 5.5 mEq/L, Cl 95 mEq/L, HCO_3 16 mEq/L

ABG: pH 7.31, $PaCO_2$ 31 mmHg

The most likely acid-base disorder is

A. Metabolic alkalosis
B. Respiratory alkalosis
C. Mixed respiratory alkalosis and metabolic acidosis
D. Metabolic acidosis
E. Mixed respiratory acidosis and metabolic alkalosis

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The most likely acid-base disorder is

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C. Mixed respiratory alkalosis and metabolic acidosis
D. Metabolic acidosis
E. Mixed respiratory acidosis and metabolic alkalosis

Winter's formula: $PaCO_2 = 1.5\,[HCO_3^-] + 8$

$= 1.5[16] + 8$

$= 32$

An acutely-ill 50-year-old woman with a history of severe vomiting for the past 4 days. Physical examination profound lethargy, a pulse rate of 120/min,a respiration rate of 12/min, and BP of 80/50 mmHg.

Serum electrolytes

Sodium	140 meq/L
Potassium	3.3 meq/L
Chloride	85 meq/L
Bicarbonate	25 meq/L

Arterial blood studies on room air:

pH 7.40 ← 1

$PaCO_2$ 41 mmHg,

An acutely-ill 50-year-old woman with a history of severe vomiting for the past 4 days. Physical examination profound lethargy, a pulse rate of 120/min,a respiration rate of 12/min, and BP of 80/50 mmHg.

Serum electrolytes

Sodium	140 meq/L
Potassium	3.3 meq/L
Chloride	85 meq/L
Bicarbonate	25 meq/L

2

Arterial blood studies on room air:

pH 7.40

$PaCO_2$ 41 mmHg,

1

Boston approach in Systemic ABG analysis

√ 1. Check arterial pH

√ 2. $[HCO_3^-]$ & $PaCO_2$ analysis

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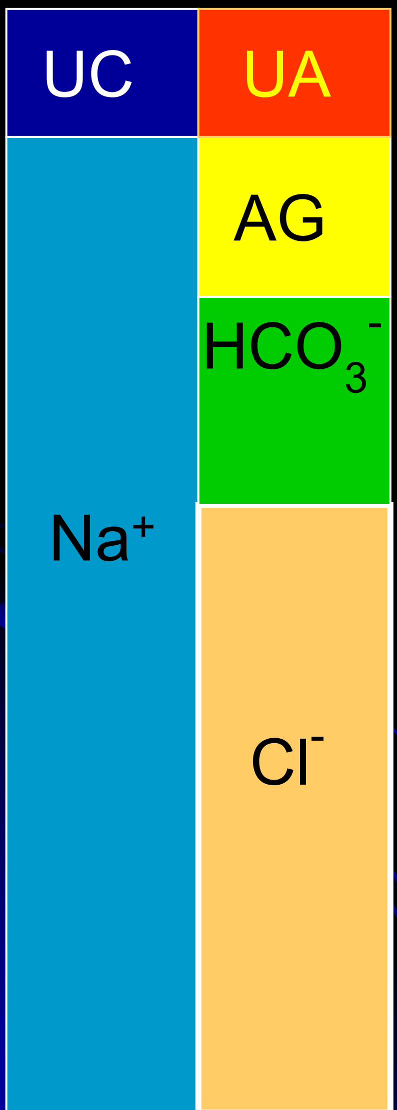
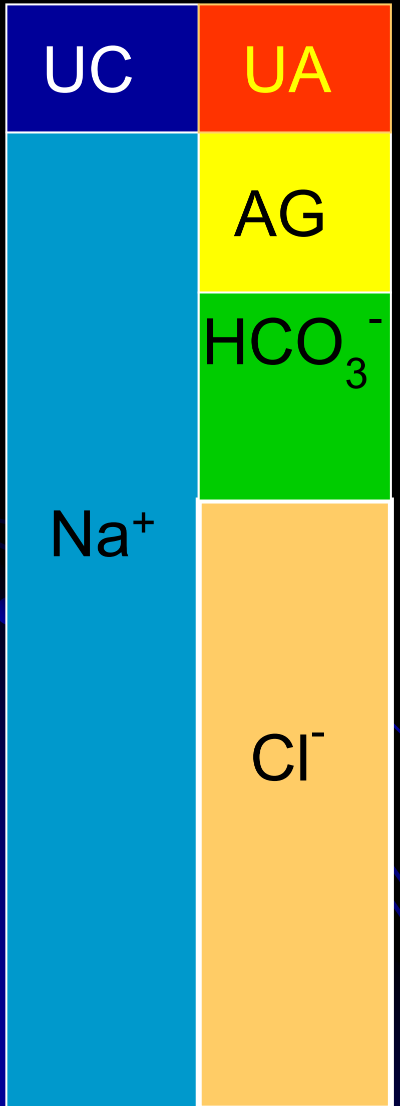
3. Calculate "Anion Gap"



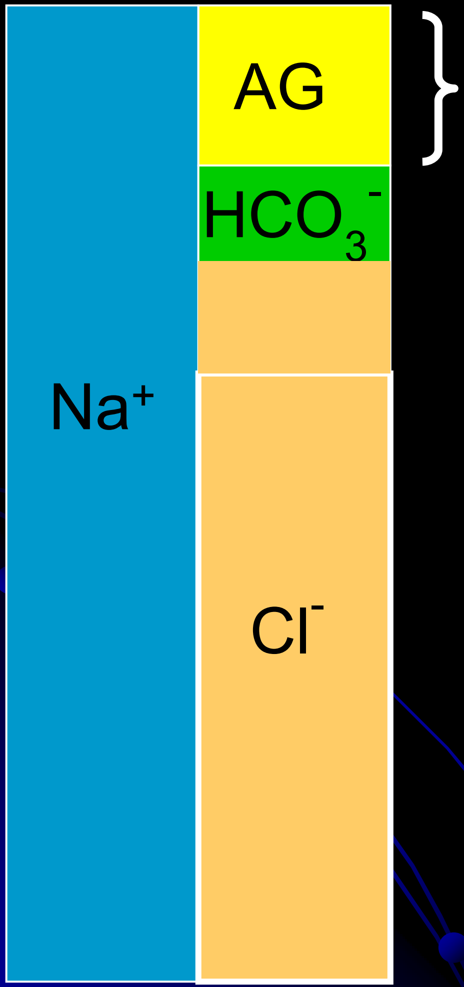
- Unmeasured cations
  K^+, Ca^{++}, and Mg^{++}
  account for about 11 mEq/L.
- Unmeasured anions
  $(PO_4)^{3-}$, SO_4^{2-}, albumin and some organic acids,
  accounting for 20 to 24 mEq/L.
- Typical anion gap is 23 − 11 = 12 mEq/L.
- The anion gap can be affected by increases or decreases in the UC or UA.

Decreased anion gap



- ↑ Unmeasured cations
  - K^+, Ca^{++}, and Mg^{++}
  - gamma globulin
- ↓ Unmeasured anions
  - $(PO_4)^{3-}$, SO_4^{2-}, albumin and some organic acids,
- The effect of low albumin can be accounted for by adjusting the normal range for the anion gap 2.5 mEq/L upward for every 1-g/dL fall in albumin.

Normal anion gap Metabolic acidosis



~ 10-12 mEq/L $\equiv [Na^+] - ([Cl^-] + [HCO_3^-])$

HCO_3^- loss

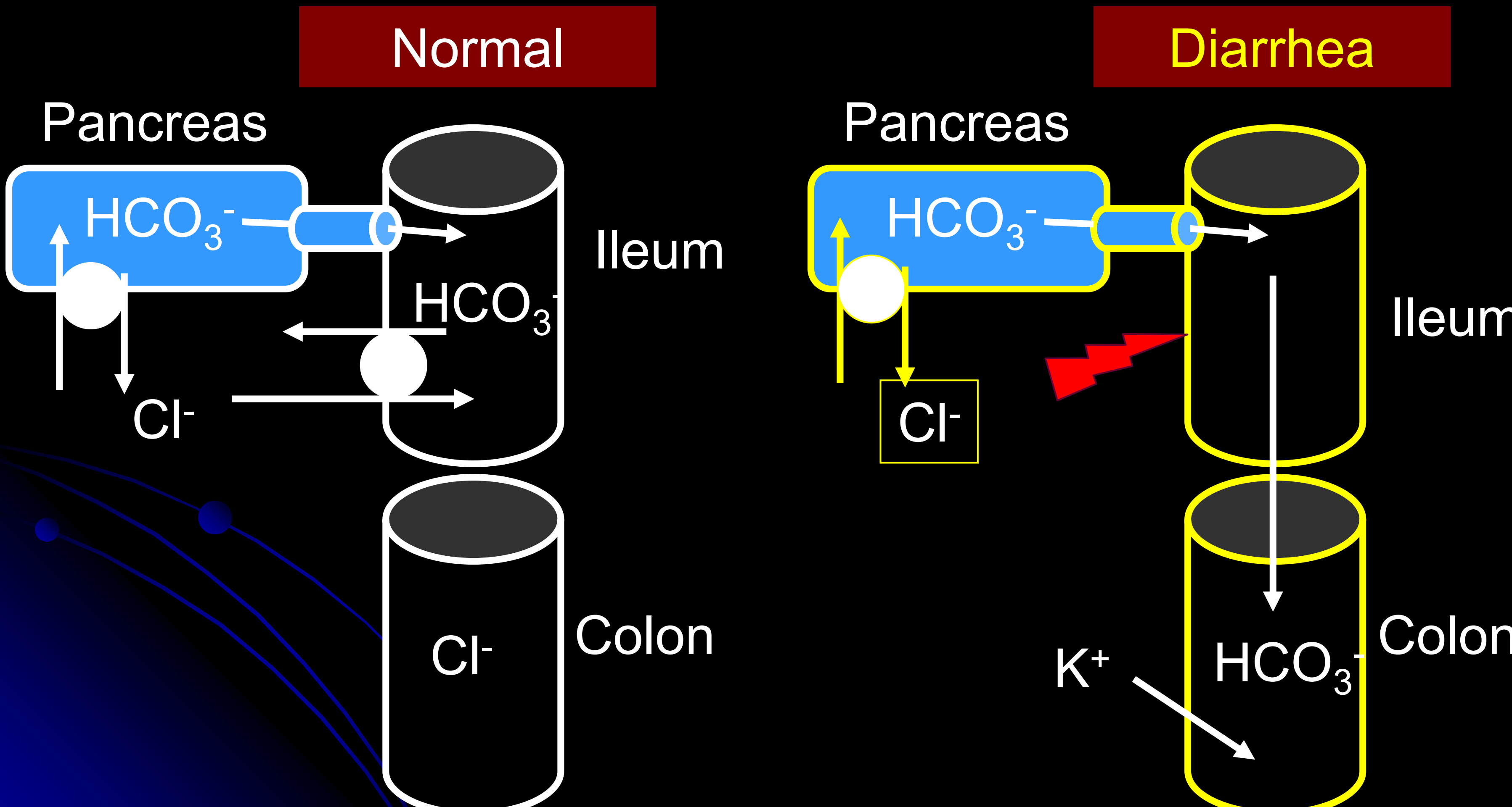
= Normal AG Metabolic acidosis

- Occur in GI tract or Renal

Causes of a “Normal anion gap” (hyperchloremic) metabolic acidosis

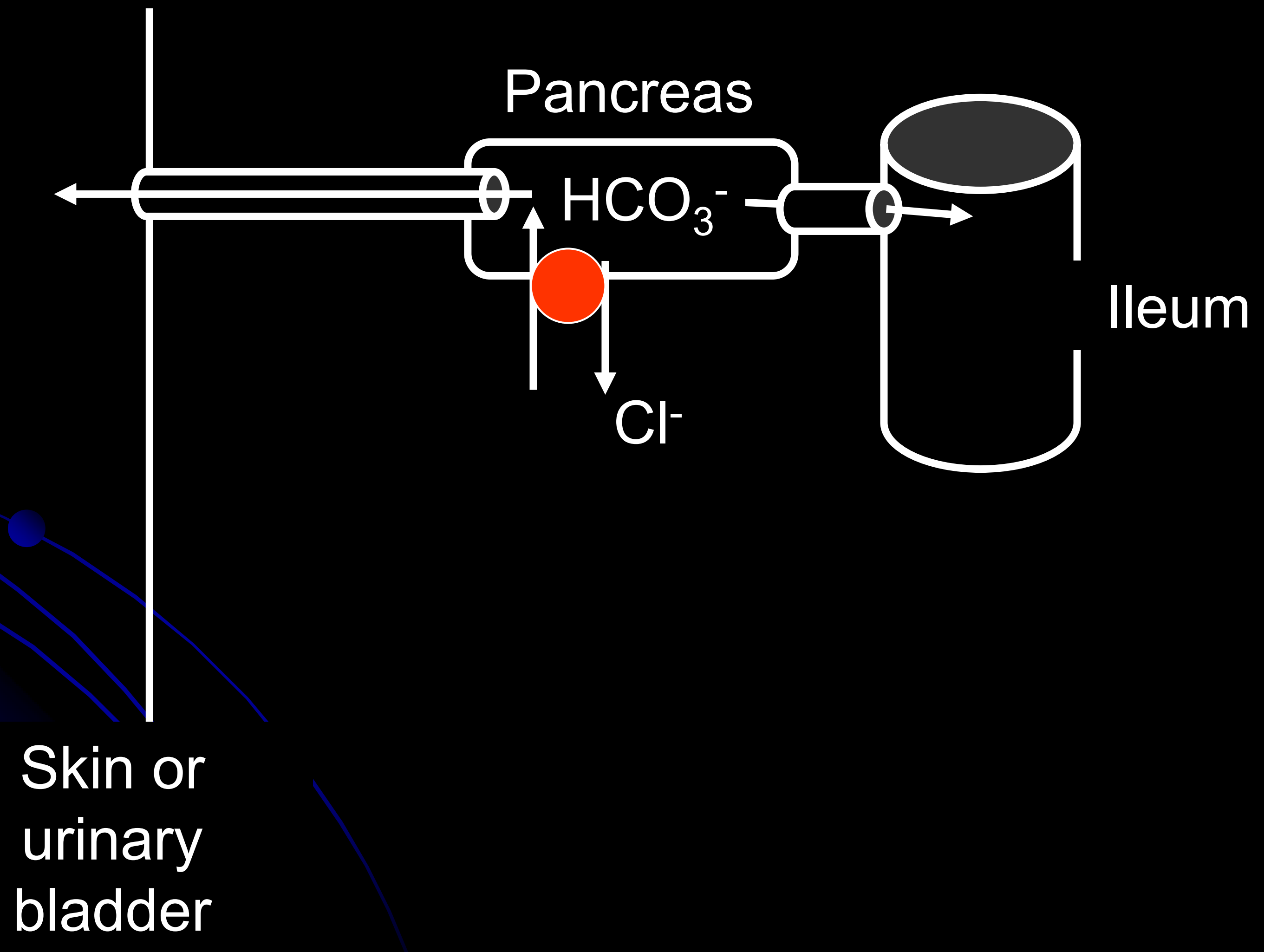
1. GI bicarbonate loss:
   - diarrhea
   - villous adenoma
   - pancreatic fistulae
   - uretero-sigmoidostomy
   - obstructed uretero-ileostomy
2. Renal bicarbonate (or equivalent) loss
   - proximal RTA, distal RTA and type IV RTA
   - early renal failure
3. Ingestions & infusions
   - ammonium chloride
   - hyperalimentation (arginine/lysine-rich)

Diarrhea Causes Loss of HCO_3^-

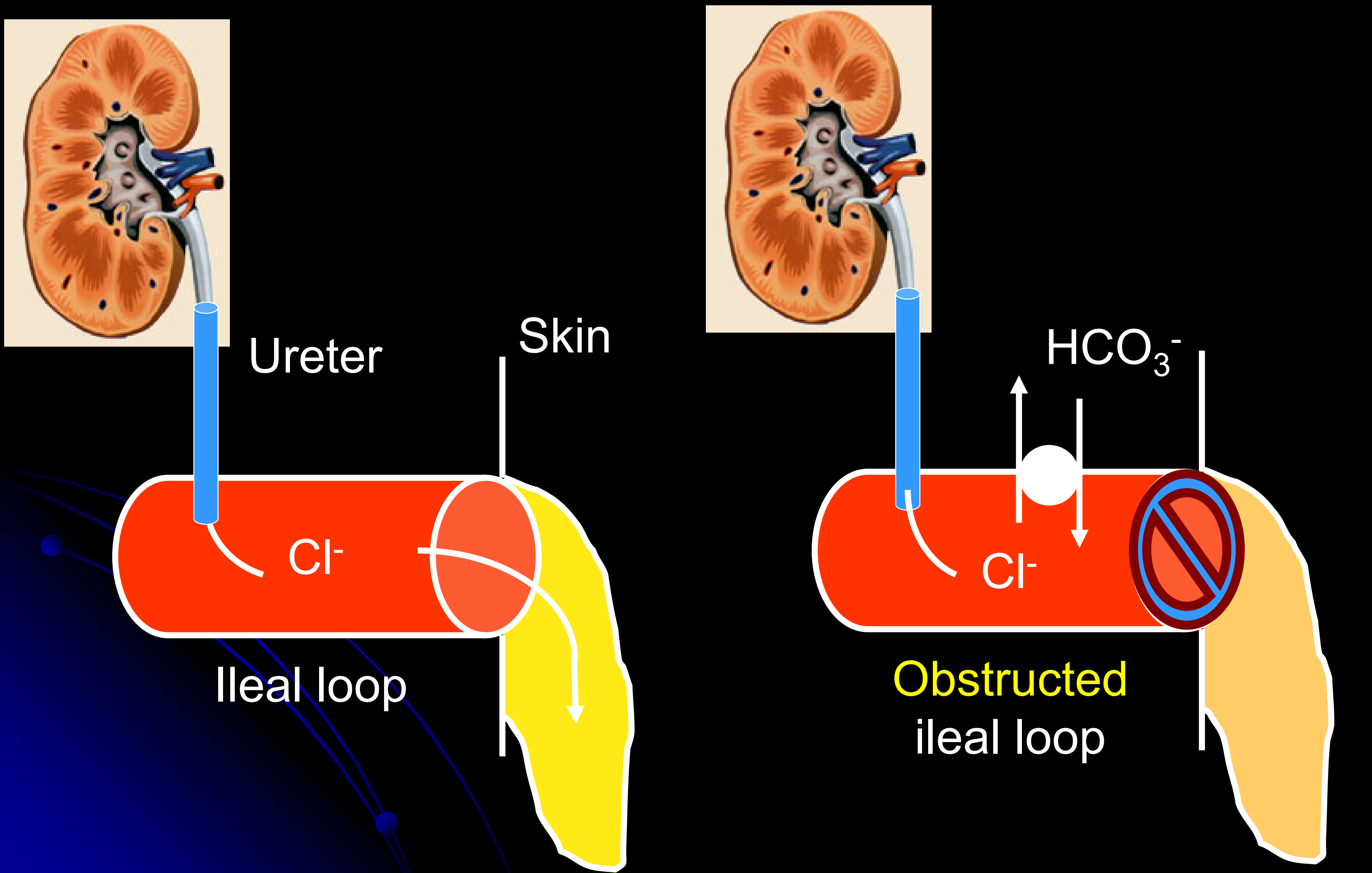


Normal AG acidosis and Hypo-K

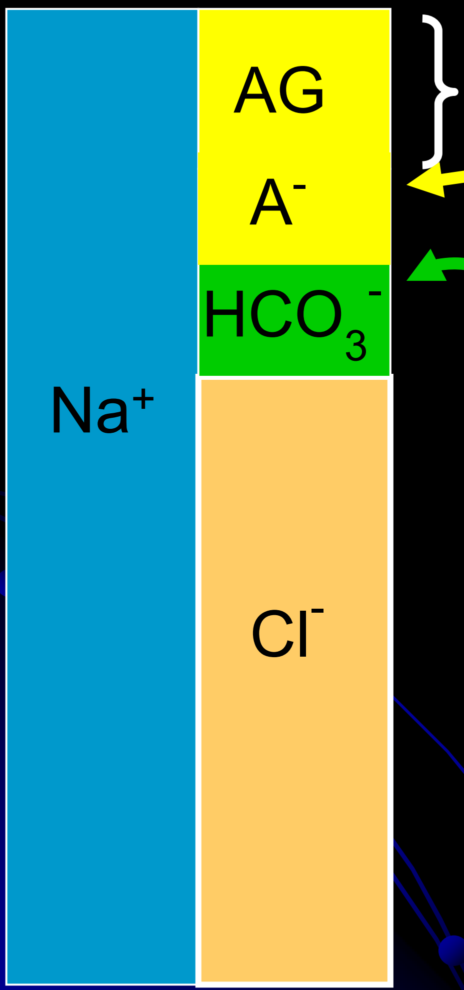
Pancreatic fistula or transplant



Obstructed Uretero-ileostomy



Wide-anion gap Metabolic acidosis

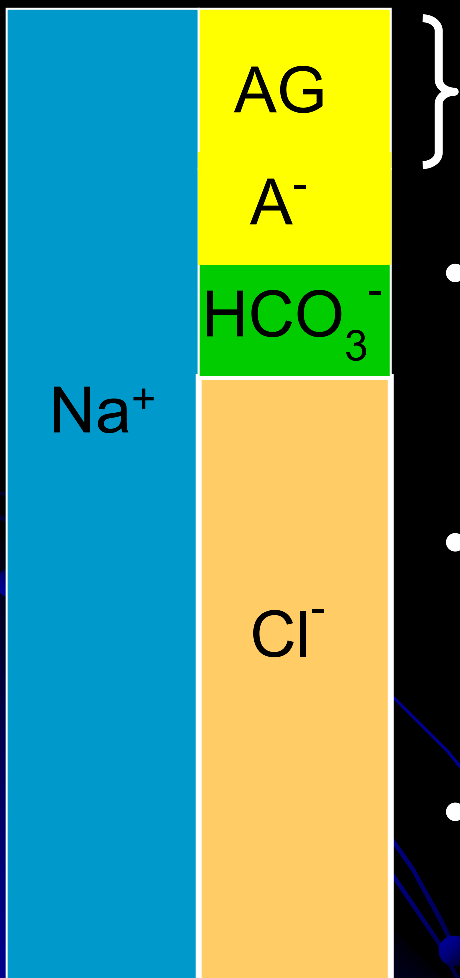


~ 10-12 mEq/L $\equiv [Na^+] - ([Cl^-] + [HCO_3^-])$

เติมกรด $HA \rightarrow H^+ + A^-$

- Organic acid load: Shock, Renal failure, DKA
- Toxic ingextation: ASA, Alcohol etc.

= Wide AG Metabolic acidosis



~ 10-12 mEq/L $\equiv [Na^+] - ([Cl^-] + [HCO_3^-])$

- AG elevated

  in either acidosis or alkalosis

- AG > 20

  67% likelihood of metabolic acidosis

- AG > 30

  ~ 100% likelihood of metabolic acidosis

An acutely-ill 50-year-old woman with a history of severe vomiting for the past 4 days. Physical examination profound lethargy, a pulse rate of 120/min,a respiration rate of 12/min, and BP of 80/50 mmHg.

Serum electrolytes

Sodium	140 meq/L
Potassium	3.3 meq/L
Chloride	85 meq/L
Bicarbonate	25 meq/L

Arterial blood studies on room air:

pH 7.40

$PaCO_2$ 41 mmHg,

1

2

3. AG = 140 – 85 -25 = 30

Boston approach in Systemic ABG analysis

√ 1. Check arterial pH
√ 2. $[HCO_3^-]$ & $PaCO_2$ analysis
√ 3. Calculate AG
4. Assess delta ratio
5. Check "clues"
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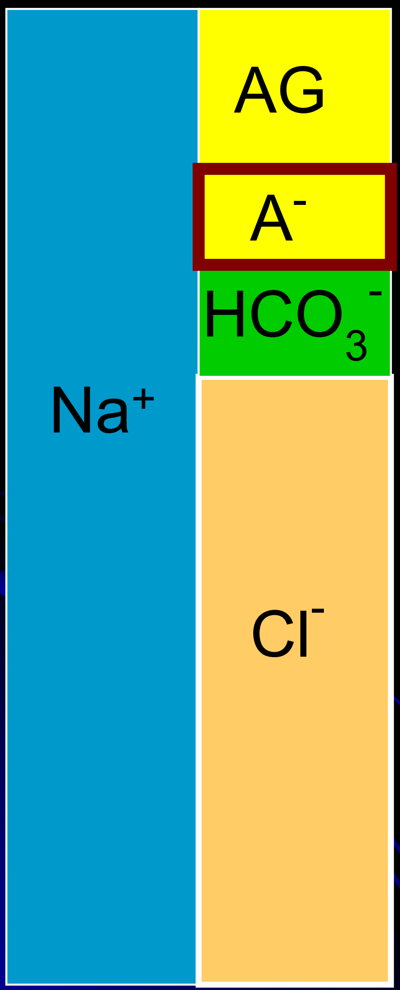
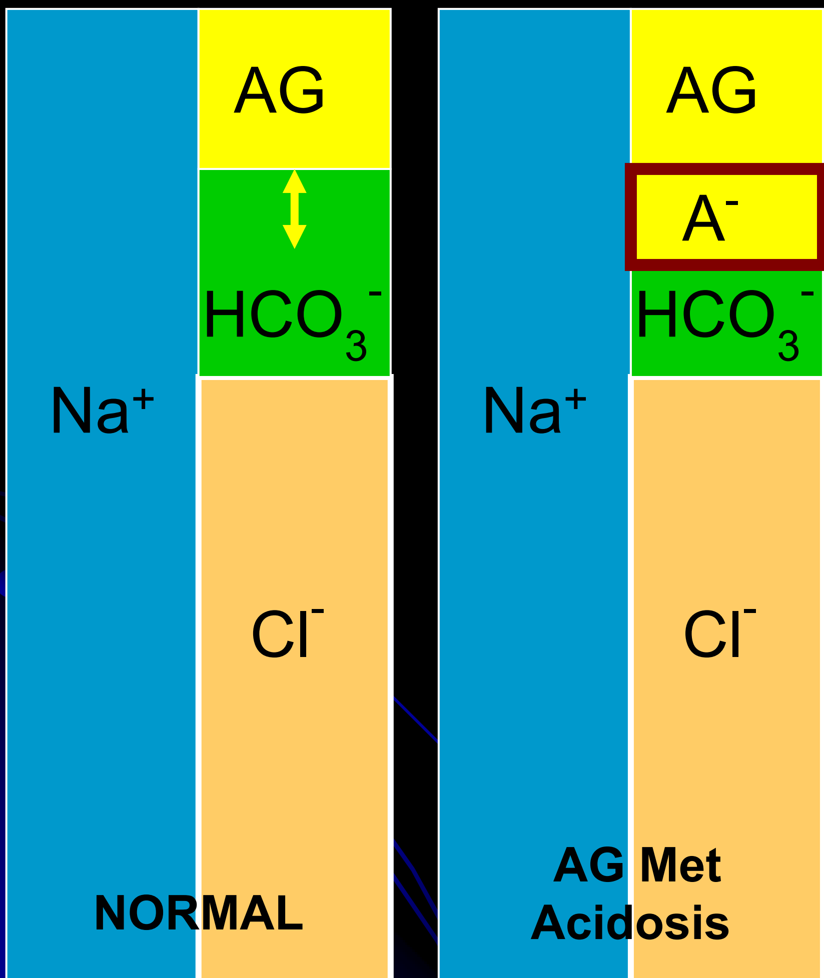
Assess delta ratio



- ↑ΔH⁺ = ↓Δ HCO_3^-
- The delta-delta ratio, to determine if a second metabolic disorder is present.
- Delta gap = $\frac{\text{Anion gap} - 12}{\Delta [HCO_3^-]}$

Assess delta ratio

Assess delta ratio

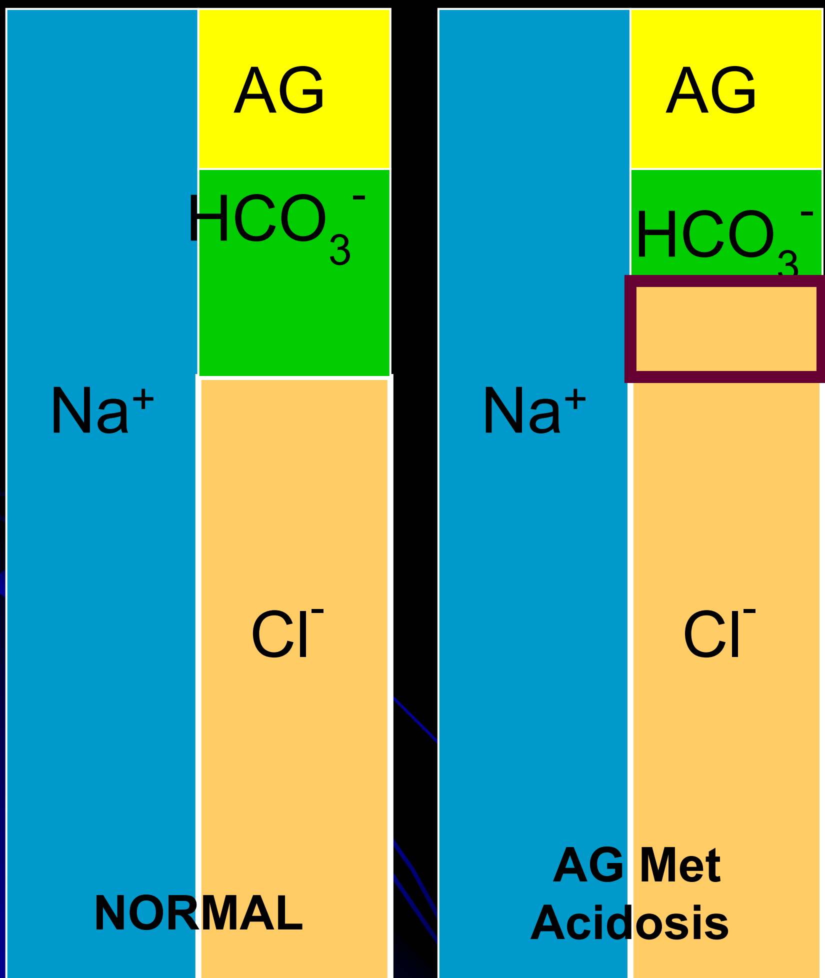


- Delta gap = $\frac{\uparrow \Delta H^{+}}{\downarrow \Delta HCO_3^{-}}$ = $\frac{\text{Anion gap} - 12}{\Delta [HCO_3^{-}]}$

1 to 2 = Pure Anion Gap Acidosis

Assess delta ratio

Assess delta ratio



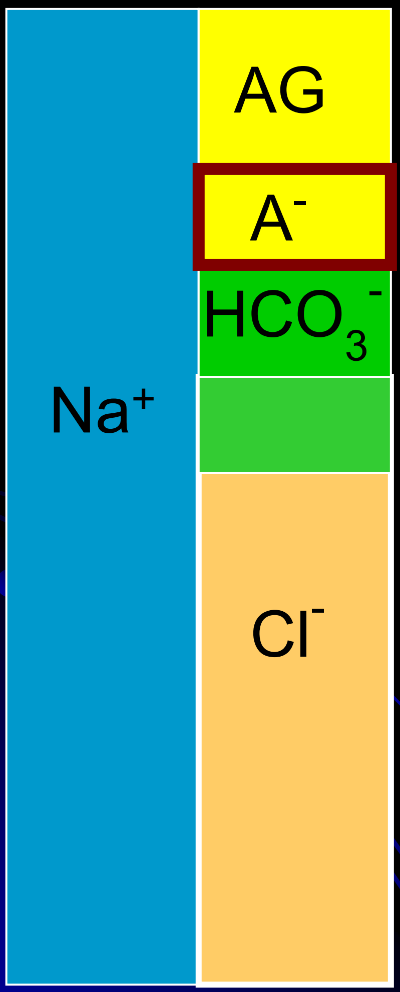
- Delta gap = $\frac{\uparrow \Delta H^+}{\downarrow \Delta HCO_3^-}$

  $= \frac{\text{Anion gap} - 12}{\Delta [HCO_3^-]}$

< 0.4 Normal AG acidosis

1 to 2 = Pure Anion Gap Acidosis

Assess delta ratio



- Delta gap = $\frac{\uparrow \Delta H^+}{\downarrow \Delta\ HCO_3^-}$

$$= \frac{\text{Anion gap} - 12}{\Delta\ [HCO_3^-]}$$

< 0.4 Normal anion gap acidosis

1 to 2 Pure Anion Gap Acidosis

> 2 High AG acidosis combined with metabolic alkalosis or pre-existing compensated respiratory acidosis

An acutely-ill 50-year-old woman with a history of severe vomiting for the past 4 days. Physical examination profound lethargy, a pulse rate of 120/min,a respiration rate of 12/min, and BP of 80/50 mmHg.

Serum electrolytes

Sodium	140 meq/L
Potassium	3.3 meq/L
Chloride	85 meq/L
Bicarbonate	25 meq/L

Arterial blood studies on room air:

pH 7.40

$PaCO_2$ 41 mmHg,

2

1

3. AG = 140 – 85 -25 = 30

4. ΔGap = 30-12/25-24 = <u>18</u>

Serum electrolytes

Sodium	140 meq/L
Potassium	3.3 meq/L
Chloride	85 meq/L
Bicarbonate	25 meq/L

Arterial blood studies on room air:

pH 7.40

$PaCO_2$ 41 mmHg

3. AG = 140 – 85 -25 = 30

4. ΔGap = 30-12/25-24 = <u>18</u>

The most like acid-base disorder is:

A Metabolic acidosis
B Metabolic alkalosis
C Respiratory acidosis and metabolic alkalosis
D Metabolic acidosis and metabolic alkalosis
E Respiratory alkalosis

A 42-year-old man is admitted to the hospital with dehydration and hypotension.

Na 165 mEq/L, K 4.0 mEq/L, Cl 112 mEq/L ,HCO_3 32 mEq/L

No arterial blood gas is obtained.

What is acid-base disturbance?

HCO_3 32 mEq/L → Met alkalosis Vs Resp acidosis

Anion gap: 165 - (32 + 112) = 21 mEq/L

→ Wide gap met acidosis

Δ gap = 21-12 = 9

→ HCO_3 should be 24 – 9 = 15

The co-existence of met acidosis and met alkalosis

Boston approach in Systemic ABG analysis

√ 1. Check arterial pH

√ 2. $[HCO_3^-]$ & $PaCO_2$ analysis

√ 3. Calculate AG

√ 4. Assess delta ratio

5. Check "clues"

6. Assess compensatory responses

7. Formulate acid-base diagnosis

Pertinent Clues

• Hyperglycaemia	DKA
• Hypo-K	Suggests metabolic alkalosis
• Hyper-K	Suggests metabolic acidosis
• Hyperchloremia	Common with normal AG metabolic acidosis
• Elevated creatinine	Uraemic acidosis or hypovolaemia

Boston approach in Systemic ABG analysis

- √ 1. Check arterial pH
- √ 2. $[HCO_3^-]$ & $PaCO_2$ analysis
- √ 3. Calculate AG
- √ 4. Assess delta ratio
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The Four Cardinal Acid Base Disorders

Disorder	pH	pCO_2	$[HCO_3^-]$
M acidosis	↓	↓	↓
M alkalosis	↑	↑	↑
R acidosis	↓	↑	↑
R alkalosis	↑	↓	↓

Rule of Metabolic acidosis

- Mechanism = ↓HCO_3^-
- 1.2(Δ↓HCO_3^-) = Δ↓$PaCO_2$
- Anion gap:

If Δ AG > 20 met acidosis 67%

If Δ AG > 30 met acidosis 100%

- Wide gap → Δ Gap
- Normal gap → Urine AG

What are the acid-base disorders in a 28-year-old man who presents to the ED with several days of vomiting, nausea and abdominal pain. His blood pressure is low and he has tenting of the skin. He has the following electrolytes:

Na 144 mEq/L

K 4.2 mEq/L

Cl 95 mEq/L

CO_2 14 mEq/L

AG = 144 - (95 + 14) = 35

Δ AG = 35 - 12 = 23

Δ HCO_3 = 27 - 14 = 13

Combined wide gap met acidosis (from dehydration and poor perfusion) *and* a met alkalosis (from vomiting and loss of stomach acid)

A 27-year-old woman with acute renal failure:

Na 140 mEq/L

K 4 mEq/L

Cl 115 mEq/L

CO_2 5 mEq/L

ABG:pH 7.12, $PaCO_2$ 13 mmHg, HCO_3 4 mEq/L

Met acidosis: AG = 140 -(115 + 5) = 20

$\Delta AG = 20-12 = 8$

$\Delta HCO_3 = 20 \rightarrow$ Delta ratio = 0.4

Combined wide-gap and normal-gap Met acidosis

Differential Dx of high-anion gap acidosis

Lactic acidosis
Salicylates
Uremia
Methanol intoxication
Paint sniffing (toluene)
Ethylene glycol intoxication
DKA or alcoholic ketoacidosis

Lactic acidosis

Type A = increased O_2 demand or decreased O_2 delivery

Type B = Malignancies (lymphoma)
Phenformin, metformin
hepatic failure
acute respiratory alkalosis (salicylates)
glycogen storage disease type I
etc

Salicylates -

± Hx aspirin ingestion,
nausea, tinnitus,
unexplained hyperventilation,
noncardiogenic pulmonary edema,
elevated prothrombin time

Usually: mixed respiratory alkalosis & metabolic acidosis (rare: pure metabolic acidosis)

Toxic at < 5 mEq/l,
so no anionic contribute to AG

No increase in osmolal gap ([ASA] < 5 mM)

Treatment for salicylate intoxication:

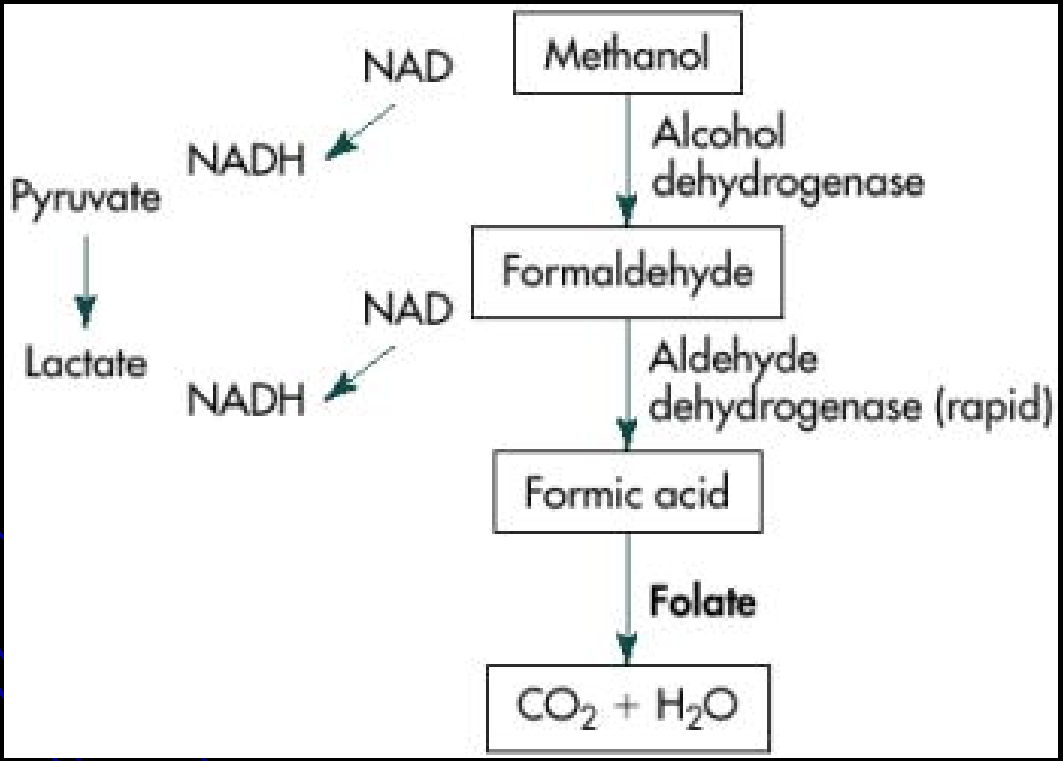
Un-ionized form (protonated) enters the brain
and is excreted poorly

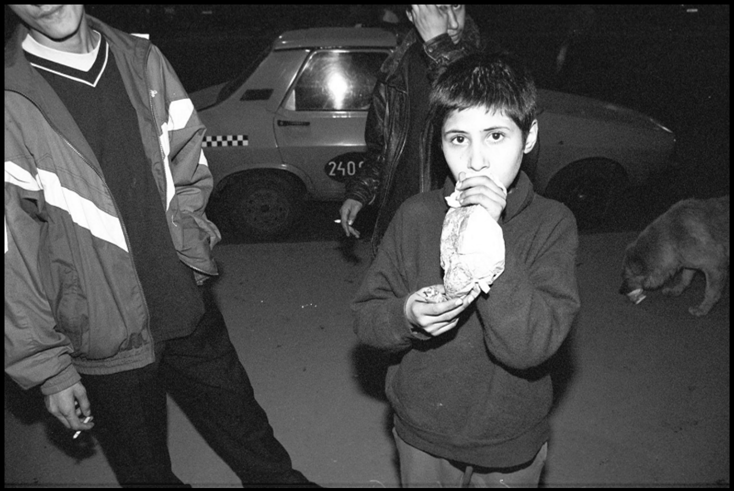
Rx….alkalinize (HCO_3 infusion) to maximize renal excretion
(dialysis)

Uremia is indicated by BUN, creatinine (chronicity by kidney size and Hct).

Methanol - presents with
± abdominal pain, vomiting,
headache; CT: BL putamen infarcts
visual disturbance (optic neuritis)

Anion gap may be > 50
Osmolal gap > 10 mOsm





Paint sniffing ("huffing")

(toluene)

may present as either
anion gap acidosis
or normal gap acidosis
Anion = hippurate

No increase in osmolal gap

Ethylene glycol

- presents with ± CNS disturbances, cardiovascular collapse, respiratory failure, renal failure

Oxalate crystals
(octahedral or dumbell)
in urine are diagnostic

Anion gap may be > 50

Osmolal gap > 10 mOsm

Diabetic ketoacidosis -

Key clinical features are:

- type I DM (i.e. no insulin)
- a trigger: e.g. sepsis, fracture, stroke
- hyperglycemia
- ECF vol depletion & renal insufficiency
- acetoacetic- and β hydroxybutyric- acids

Alcoholic ketoacidosis -

recent stopping ingestion of ethanol, hypoglycemia, and contracted ECF (usually due to vomiting)

Initial administration of fluid during the resuscitation of a patient who has a gun short wound of the thorax and abdomen results in a rise in blood presssure to 110/80 mmHg. At this point, arterial blood gases are pH, 7.25; PO_2, 95 mmHg; PCO_2 25 mmHg; HCO_3^- 15 mEq/L. The patient's metabolic acidosis would be treated best with

A. Tromethamine (Tham)
B. Sodium bicarbonate
C. Dextran 70
D. Balanced salt solution
E. Hyperventilation

Metabolic alkalosis may be caused by all of the following EXCEPT

A. Gastric outlet obstruction with vomiting

B. Diarrhea

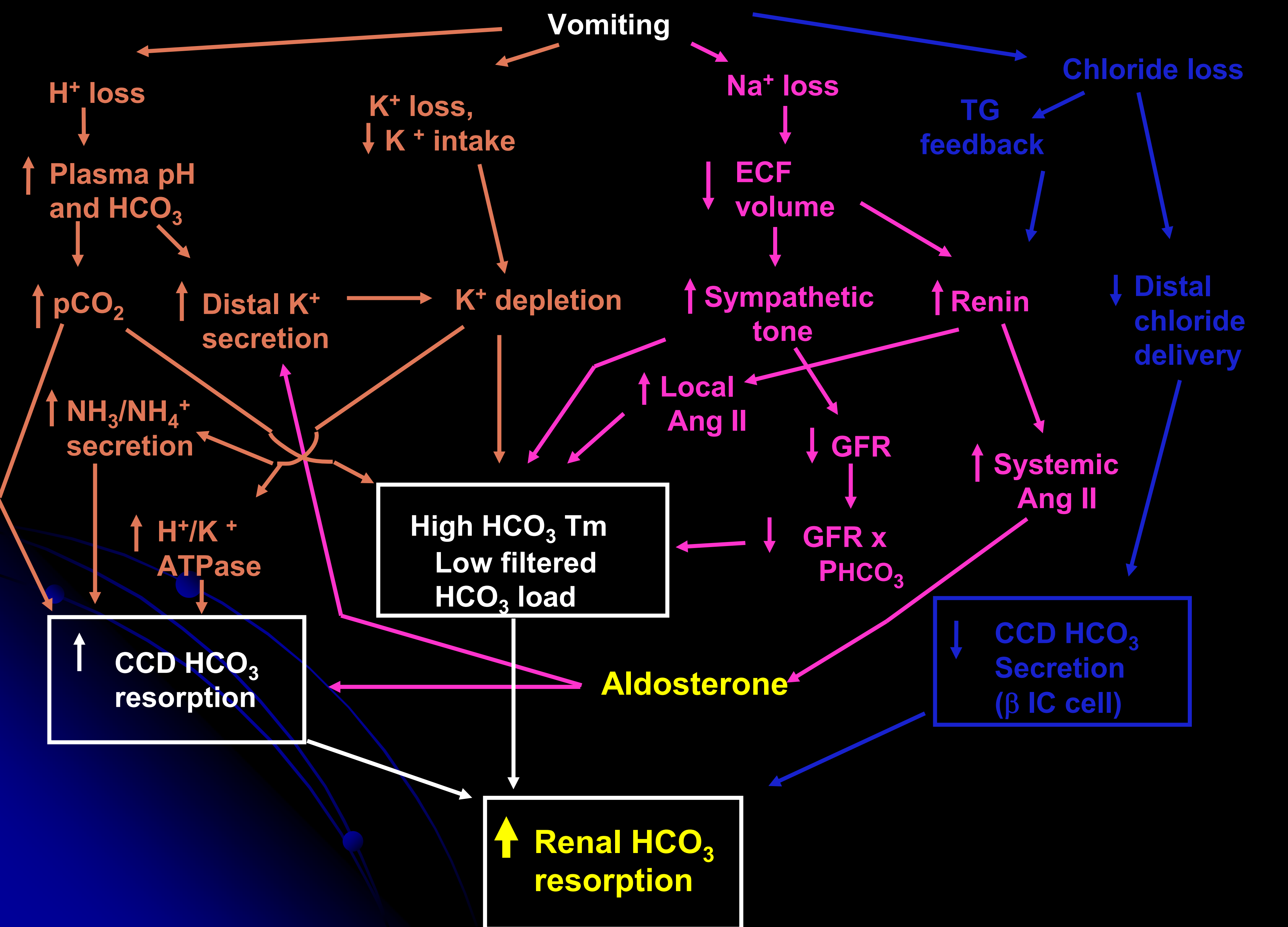
C. Magnesium deficiency

D. Diuretics

E. Cushing syndrome

The Four Cardinal Acid Base Disorders

Disorder	pH	pCO_2	$[HCO_3^-]$
M acidosis	↓	↓	↓
M alkalosis	↑	↑	↑
R acidosis	↓	↑	↑
R alkalosis	↑	↓	↓



Vomiting
H+ loss
↑ Plasma pH and HCO3
↑ pCO2
↑ Distal K+ secretion
↑ NH3/NH4+ secretion
↑ H+/K + ATPase
K+ loss, ↓ K + intake
K+ depletion
Na+ loss
↓ ECF volume
↑ Sympathetic tone
↑ Local Ang II
↓ GFR
↓ GFR x PHCO3
↑ Renin
↑ Systemic Ang II
Chloride loss
TG feedback
↓ Distal chloride delivery
↓ CCD HCO3 Secretion (β IC cell)
High HCO3 Tm Low filtered HCO3 load
↑ CCD HCO3 resorption
Aldosterone
↑ Renal HCO3 resorption

DIFFERENTIAL DIAGNOSIS OF METABOLIC ALKALOSIS USING URINE Cl

Low Urine [Cl^-]	Normal Urine [Cl^-]
Vomiting NG suction	Mineralocorticoidism RAS, aldosteronism 11-bDH deficiencies Bartter's
Diuretics (late)	Diuretics (early)
Posthypercapnia	Severe K^+ depletion
Cystic fibrosis	
Low Cl^- intake	

A 54 year-old man has been vomiting for three days and has lost 5% of his body weight. His serum electrolytes are as follow: Na 136 mEq/L, K 3.1 mEq/L, Cl 88 mEq/L, HCO_3 37 mEq/L

Which of the following is most helpful in determining the cause of his acid-base disorder?

A. Urine Sodium

B. Urine Creatinine

C. Urine Chloride

D. Urine anion gap

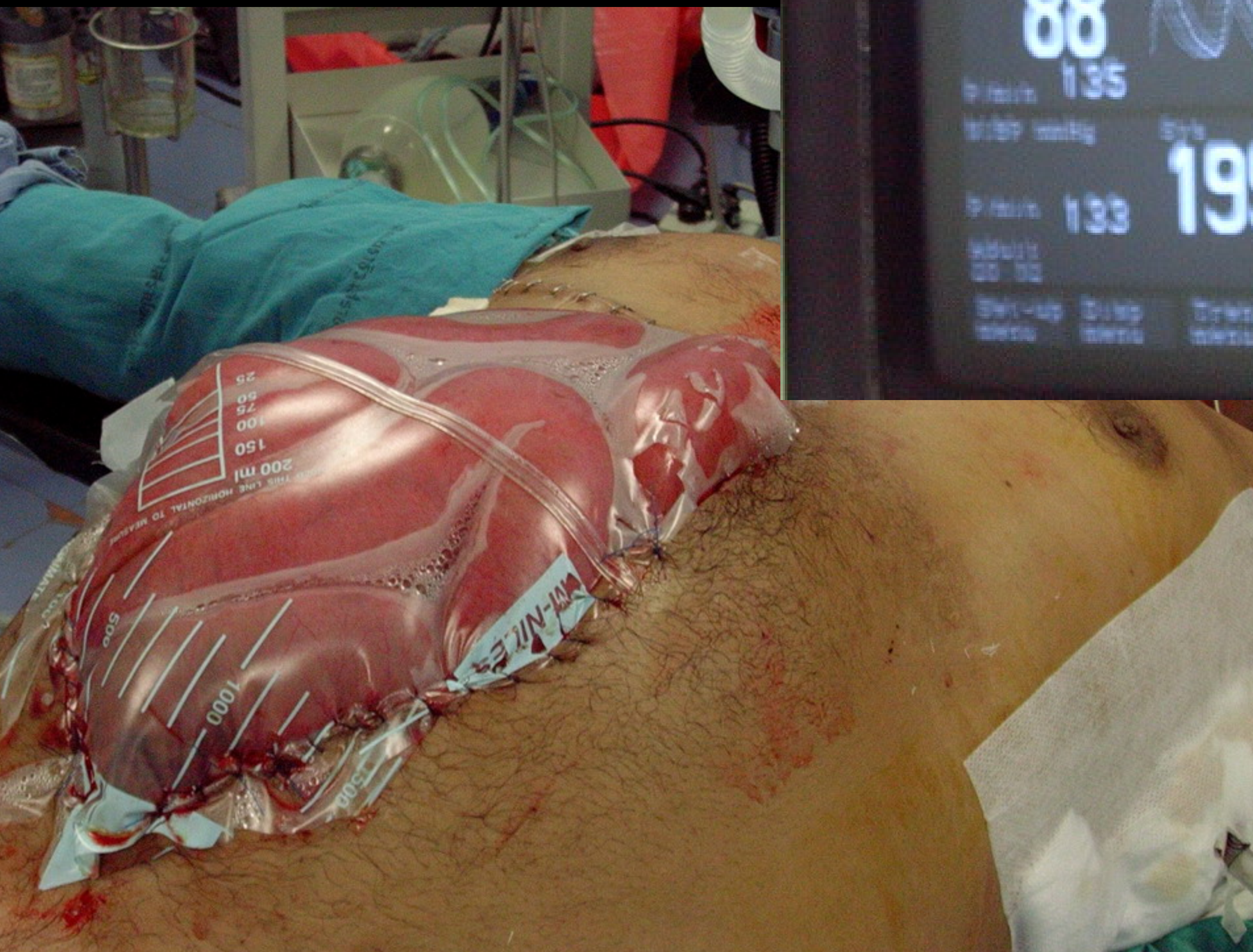
E. Urine pH

The most important ion to replace in a patient dehydrated after several days of emesis from an obstructing pyloric channel ulcer is

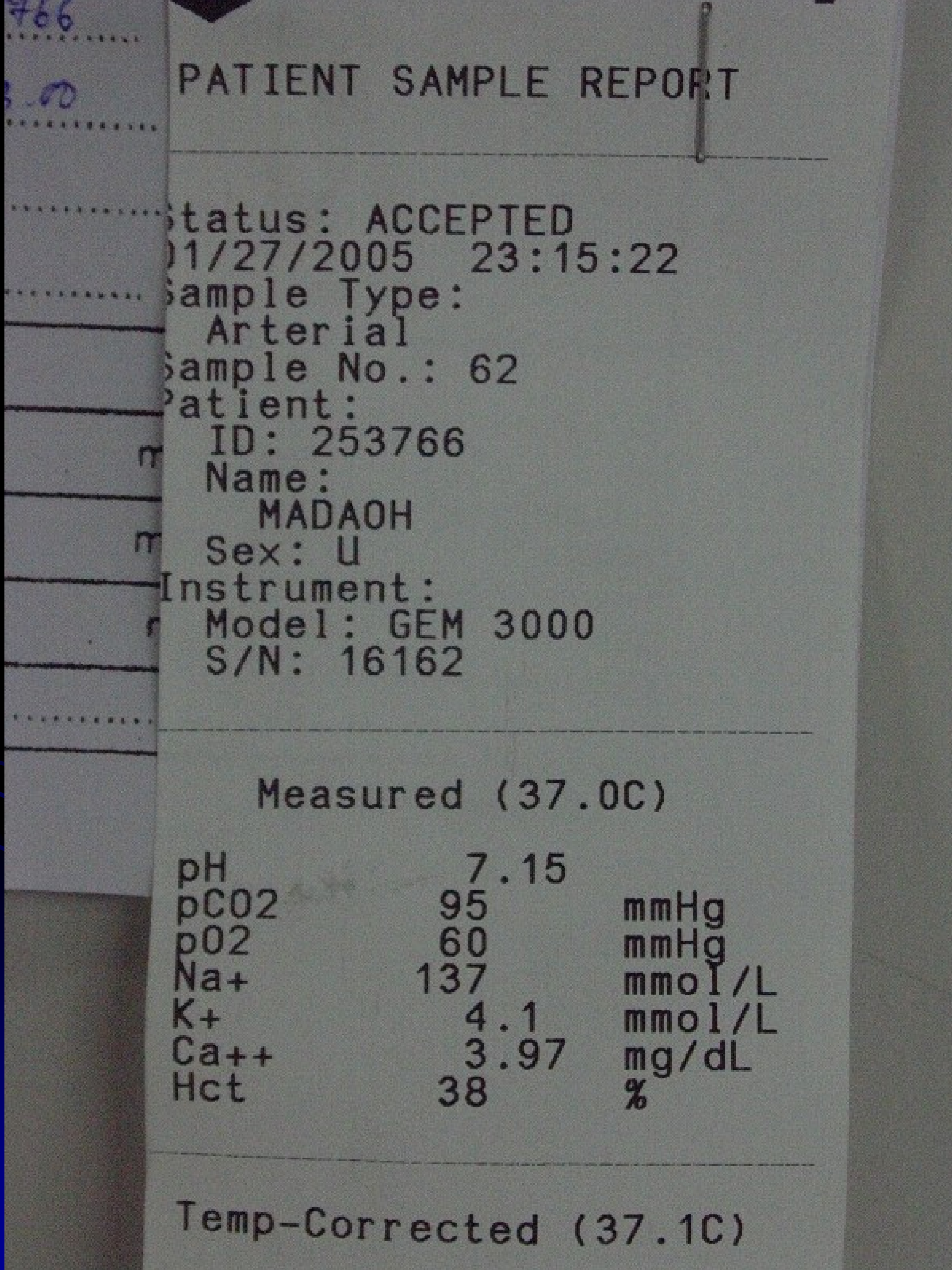
A. bicarbonate
B. chloride
C. hydrogen
D. potassium
E. sodium

The Four Cardinal Acid Base Disorders

Disorder	pH	pCO_2	$[HCO_3^-]$
M acidosis	↓	↓	↓
M alkalosis	↑	↑	↑
R acidosis	↓	↑	↑
R alkalosis	↑	↓	↓



SpO₂ Low ALARM
135
88
135
133
199 / 127
(136)
Record menu



PATIENT SAMPLE REPORT

Status: ACCEPTED
01/27/2005 23:15:22
Sample Type:
Arterial
Sample No.: 62
Patient:
ID: 253766
Name:
MADAOH
Sex: U
Instrument:
Model: GEM 3000
S/N: 16162

Measured (37.0C)

pH	7.15	
pCO2	95	mmHg
pO2	60	mmHg
Na+	137	mmol/L
K+	4.1	mmol/L
Ca++	3.97	mg/dL
Hct	38	%

Temp-Corrected (37.1C)

Causes of Respiratory Acidosis

Acute

10 mm Hg ↑ pCO_2 →
1 mEq/L ↑ HCO_3^-

Asthma

Pulmonary edema

Drug overdose

Cardiac arrest

Sleep apnea

Chronic

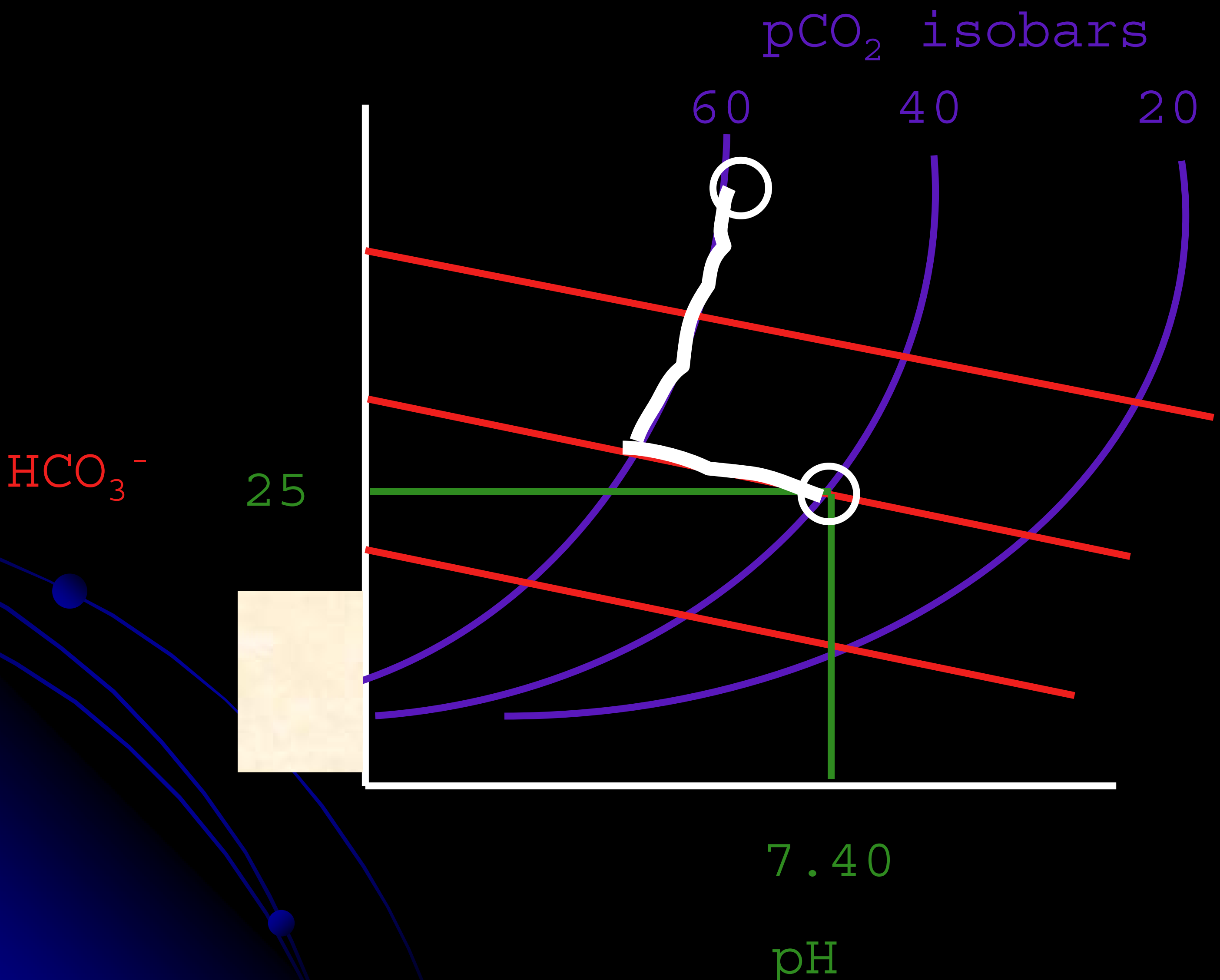
10 mm Hg ↑ pCO_2 →
3.5 mEq/L ↑ HCO_3^-

Chronic Obstructive Pulmonary Disease (COPD)

Obesity/Pickwickian

Neuromuscular (e.g. Lou-Gehrig's)

Acute Vs Chronic Respiratory Acidosis



Triple Ripple

Disorder	pH	pCO_2	$[HCO_3^-]$
M acidosis	↓	↓	↓
M alkalosis	↑	↑	↑
R acidosis	↓	↑	↑
R alkalosis	↑	↓	↓

WHAT IS THE ACID-BASE DISTURBANCE?

145	□	95	□	30
3.5	□	25	□	1.8

RA-ABG: 7.50 /pCO2 33 /pO2 105

1. Respiratory alkalosis

2. Anion gap = 145 - (95+25) = 25
   → Wide-gap met acidosis

3. Δ Gap = 25-12 = 13
   Δ HCO_3 = 1pH is high = metabolic alkalosis

This is the "Triple Ripple"

- A 60-yr-old man with the odor of alcohol on his breath is brought to ER. He is hypotensive, hypothermic, and tachycardia. At admission, laboratory documented :
  Na 135, K 3.9, Cl 90, HCO_3 15
  BUN 42 Cr 2.0
  Blood Sugar 120
  ABG : pH 7.36 pO_2 80 pCO_2 40
  Which of the following is the most accurate description of this patient's acid-base disorder ?

AG = 30

A. ~~Simple metabolic acidosis~~
B. ~~Respiratory acidosis and metabolic acidosis~~
C. Metabolic acidosis and respiratory alkalosis
D. Met acidosis, met alkalosis, and respiratory acidosis
E. ~~Met acidosis, respiratory alkalosis, and respiratory acidosis~~

Thank You