Acid-Base Revealed

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Leading Specialty Healthcare for Pets

Acid-Base Revealed

PCO_2

HCO_3^-

- Acid-Base Physiology
  - Why is it important?
  - What happens?
  - What is measured?
  - Acid-Base Analysis
    - pH, PCO_2, HCO3-, BE, AG, semi-quantitative

- Acid-Base Disorders
  - Types
    - Metabolic acidosis
    - Metabolic alkalosis
    - Respiratory acidosis
    - Respiratory alkalosis
  - Acid-Base interpretation
    - Acid-Base examples

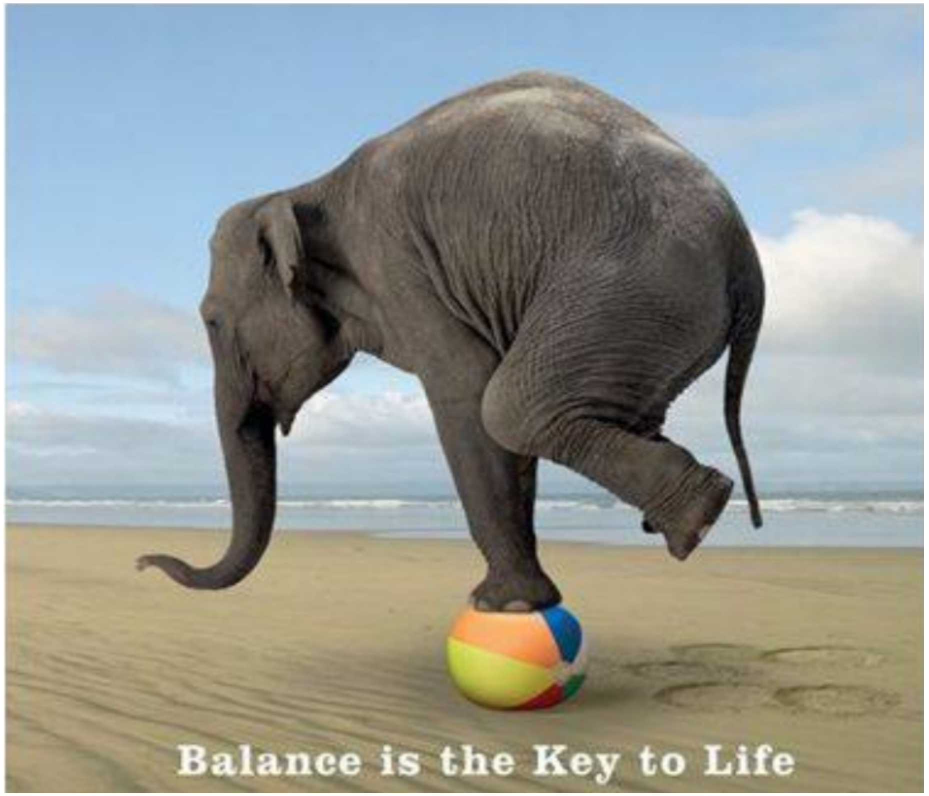
pH

Acid–Base Physiology: Why is it Important?

- To maintain homeostasis the body must maintain normal acid-base balance

  - **Homeostasis –** is the tendency to resist change in order to maintain a stable, relatively constant internal environment

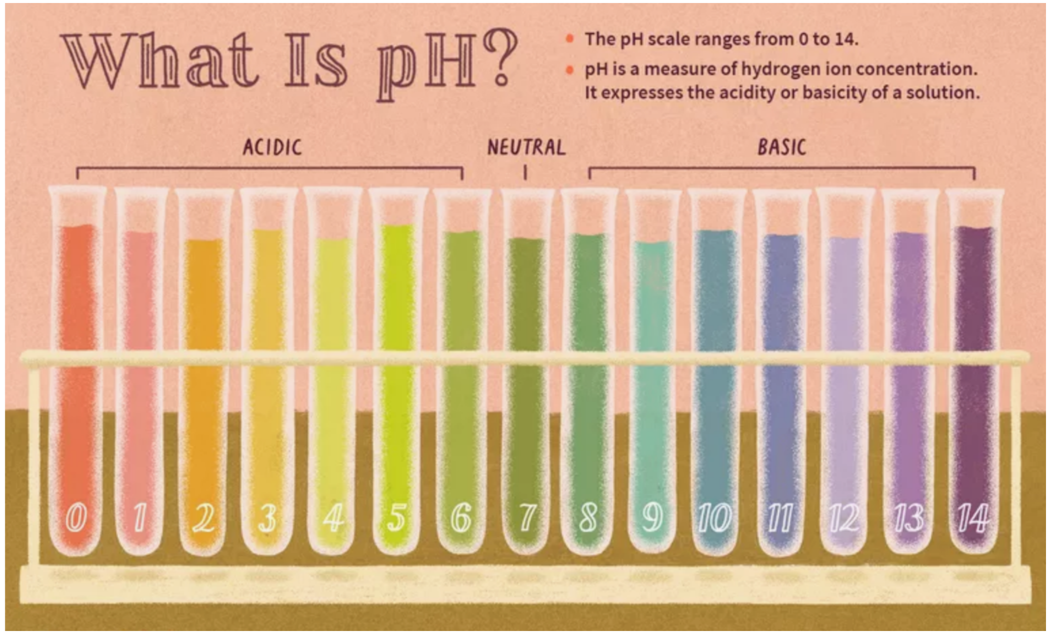
- Examples – maintaining body temperature, pH (acid-base balance), various ions in the blood, blood glucose



Acid–Base Physiology: Why is it Important?

- What is pH?
  - A number expressing the acidity or alkalinity of a solution
  - Neutral pH is ---- 7.0
  - Acidic pH is ---- lower than 7.0
  - Alkaline pH is ---- higher than 7.0

  - **Neutral pH is different from normal pH**



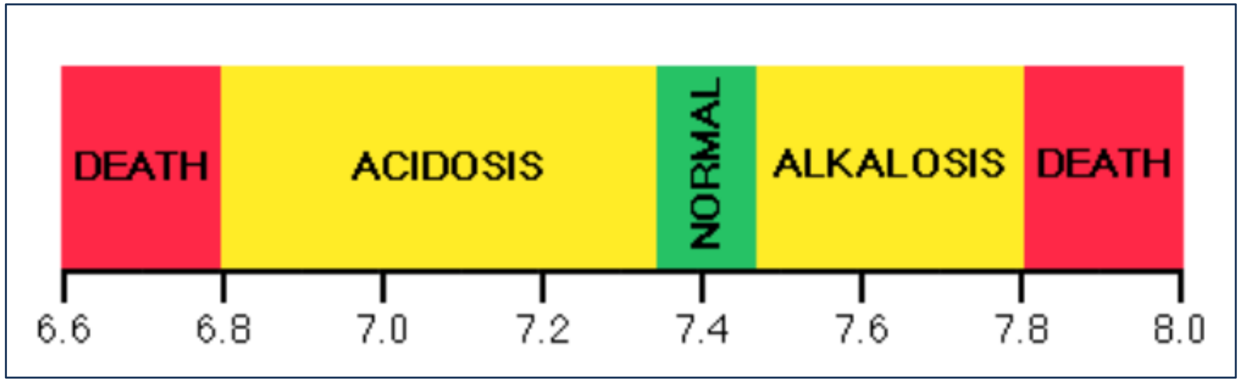
Acid–Base Physiology: Why is it Important?

- Normal pH in the body is 7.35 to 7.45

  Why this number?

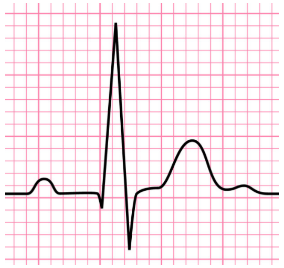
  - **pH of 7.35 to 7.45 is optimal for biological functions**

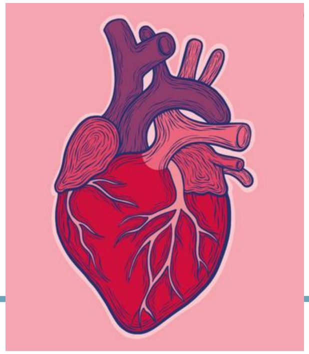
  - Acidosis/acidemia: pH below 7.35
  - Alkalosis/alkalemia: pH above 7.45



Acid–Base Physiology: Why is it Important In Critical Care?

- Oxygen delivery to tissues
  - Hemoglobin's affinity for O_2
- Cardiac muscle function
  - Perfusion, oxygen, cardiac output
- Vascular smooth muscle function
  - Hypotension if decreased tone
- Movement of ions
  - Sodium
  - Potassium
  - Calcium
- Mitochondrial function
  - Tissues cannot utilize O_2 if dysfunction
- Brain function
  - Mentation, neurotransmitter function
- Gastrointestinal function
  - Ileus, regurgitation, emesis
- Hormones
  - E.g. insulin, ACTH, renin-angiotensin-aldosterone system





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pH

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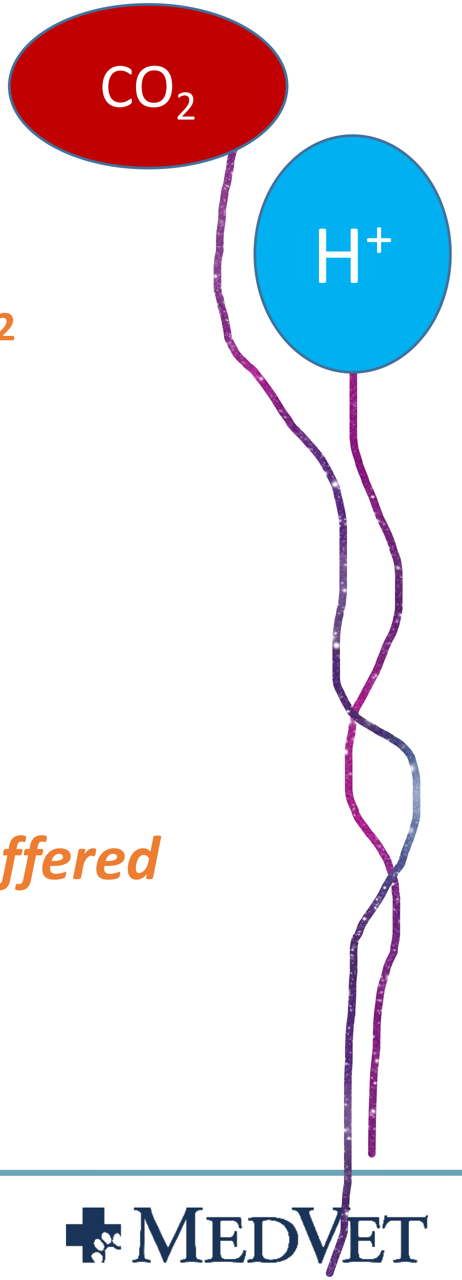
Acid–Base Physiology: What Happens?



- Metabolic processes each day produce an acid load
- Metabolism of proteins & phospholipids →10,000-15,000 mmol of **CO_2**
- Metabolism of carbohydrates & fats → 50-100 mEq of **H^+**

  - pH is reflection of H^+ (hydrogen ion) concentration in the body
  - pH depends on the ratio of bicarbonate (HCO_3^-) to PCO_2

- ***To maintain normal acid-base balance this daily acid load must be buffered (neutralized) and/or excreted***

Acid–Base Physiology: What Happens?

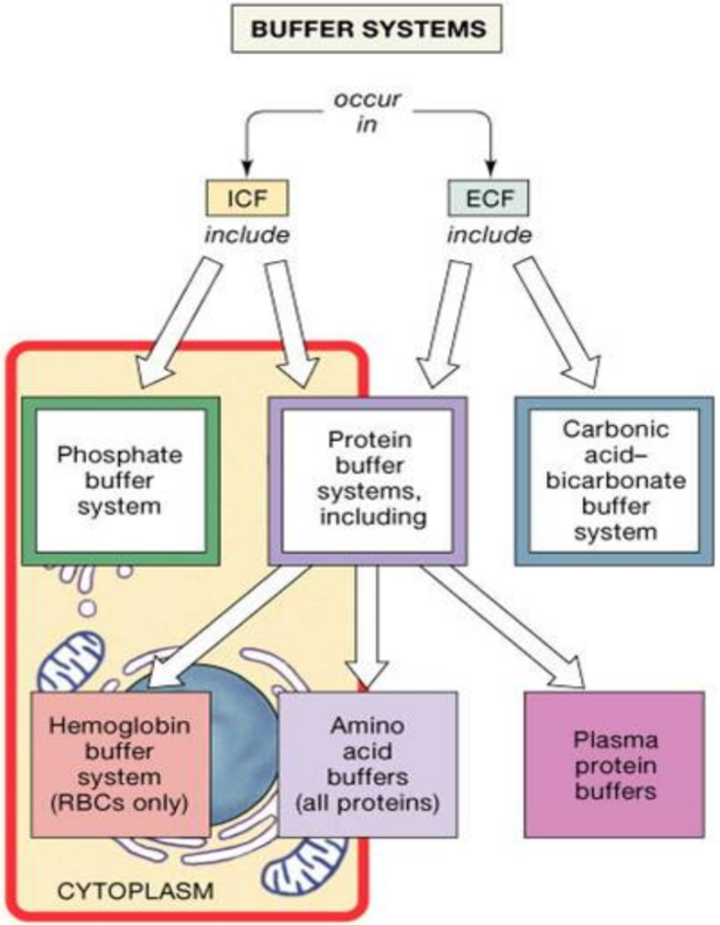
- Acid and Base:
  - Acid = proton (H^+)
  - Base = negatively charged ion that will react with a proton

H^+

- Maintenance of acid-base balance occurs via three processes:
  1) Regulation of **PCO_2** by alveolar ventilation
  2) Buffering of acids by **bicarbonate** and nonbicarbonate buffers
  3) Changes in **renal excretion** of acid or base

Acid–Base Physiology: What Happens?

- What is a buffer?
  - A buffer is a solution that resists a change in pH on addition of small amounts of acids or alkali
- Buffers in the body
  - **Bicarbonate** – primary buffer
  - Proteins – hemoglobin, plasma proteins
  - Phosphates – intracellular



Acid–Base Physiology: What Happens?

Lungs regulate CO_2
- Minutes to hours
- Rapid response

Carbonic acid equation

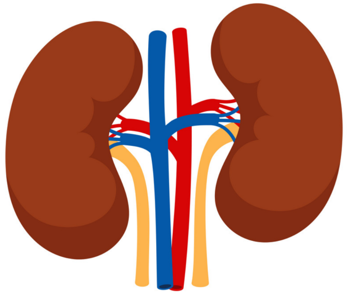
carbonic acid: H_2CO_3

bicarbonate: HCO_3^-

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

pH

Kidneys regulate HCO_3^-
- Hours to days
- Slower response



The Bicarbonate-Carbonic Acid Buffer System

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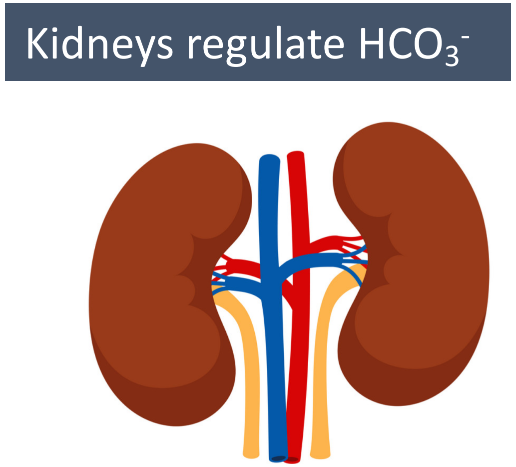
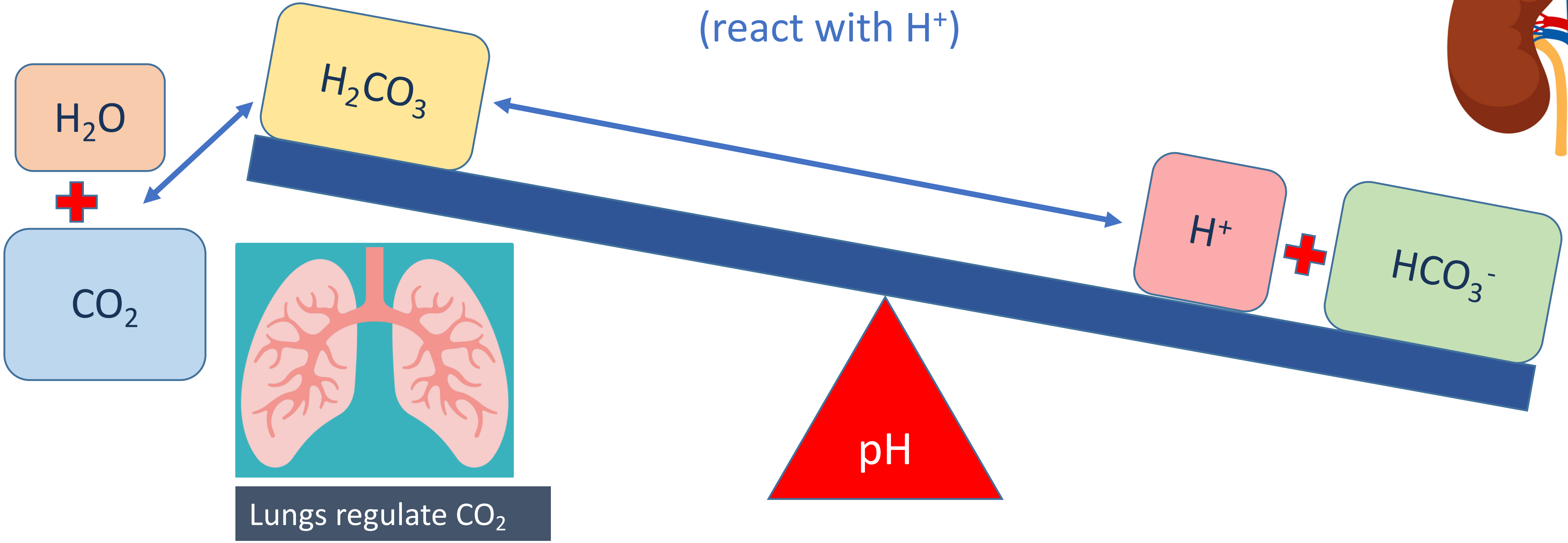
Acid–Base Physiology: What Happens?

Acid load (addition of H^+)

- shifts equation to the left
- buffers titrate H^+ (react with H^+)

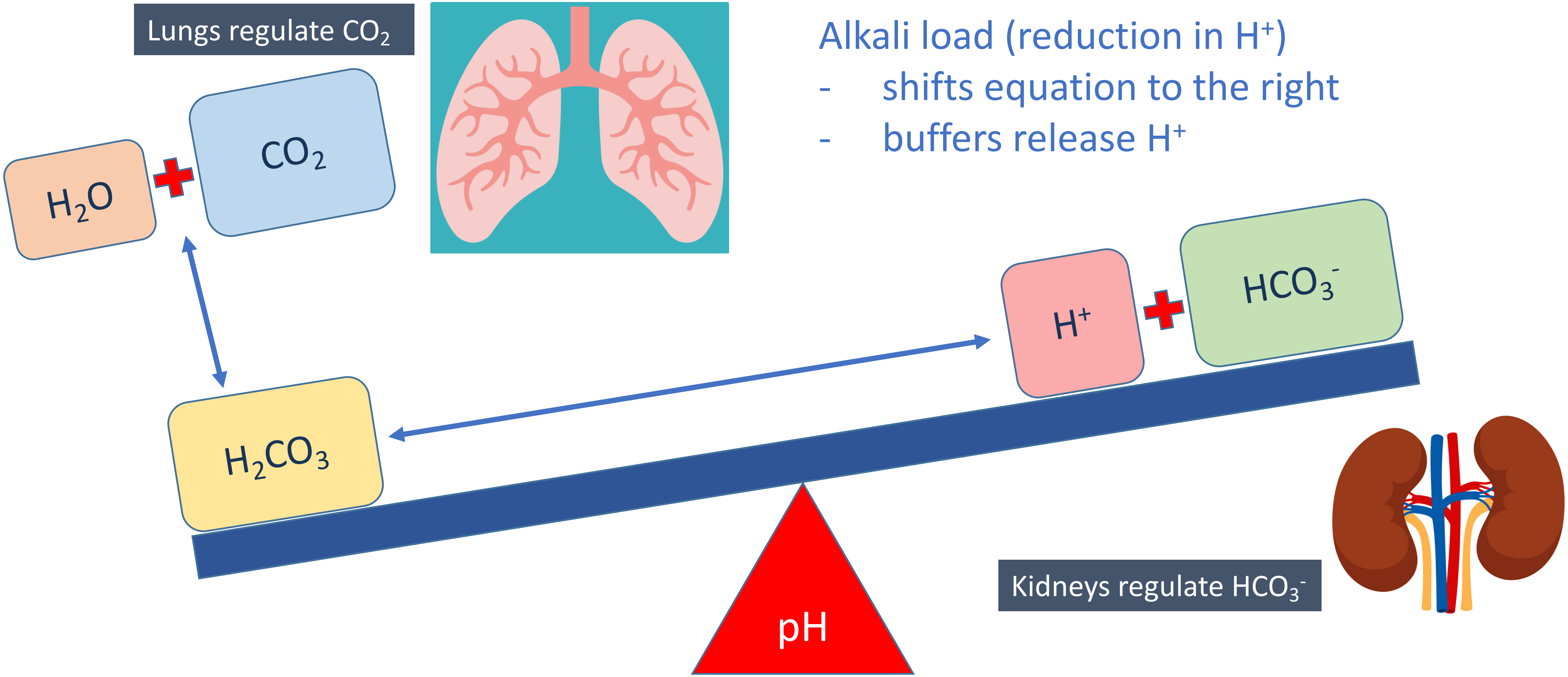




Acid–Base Physiology: What Happens?

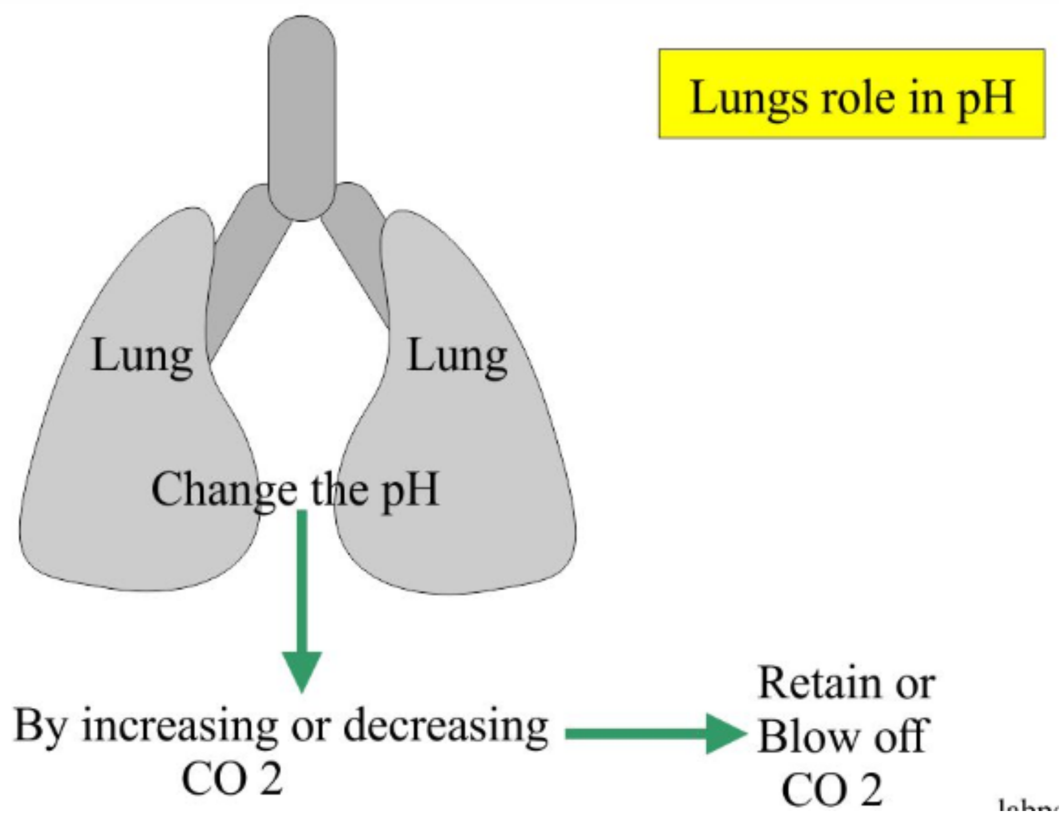
Alkali load (reduction in H^+)

- shifts equation to the right
- buffers release H^+



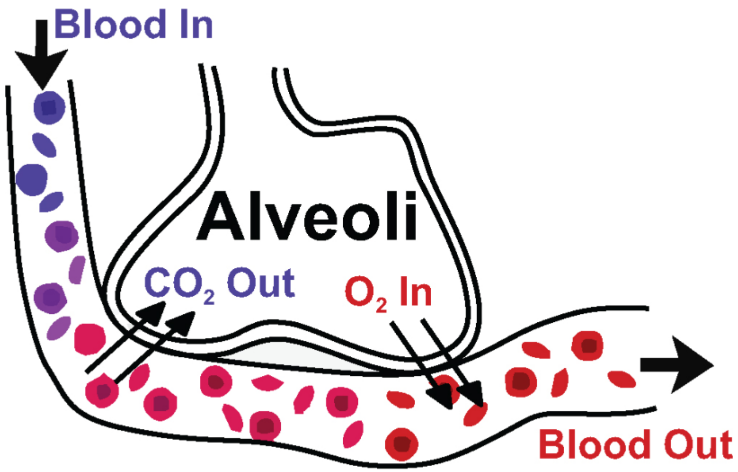
Acid–Base Physiology: What Happens?

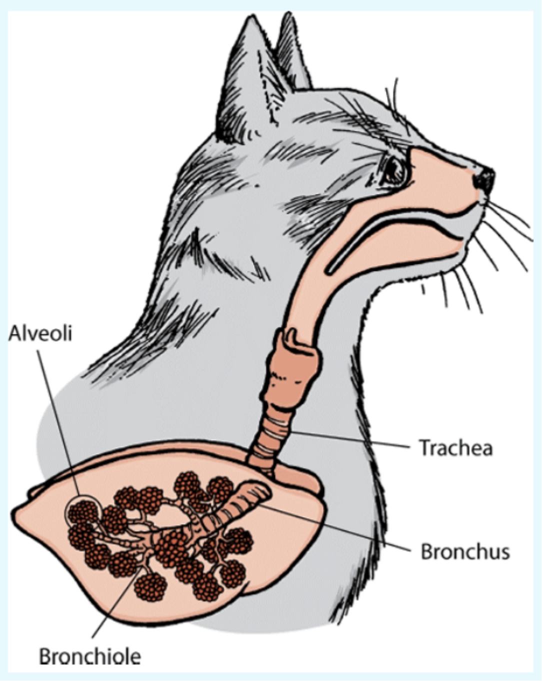
- Tissues produce CO_2
- Lungs regulate CO_2 by excreting it
- PCO_2 level controls respiratory rate
- PCO_2 maintained at ~40 mm Hg
- Very efficient – can lower the PCO_2 to below normal to restore pH → "open" system
- PCO_2 = **Respiratory** component



Acid–Base Physiology: What Happens?

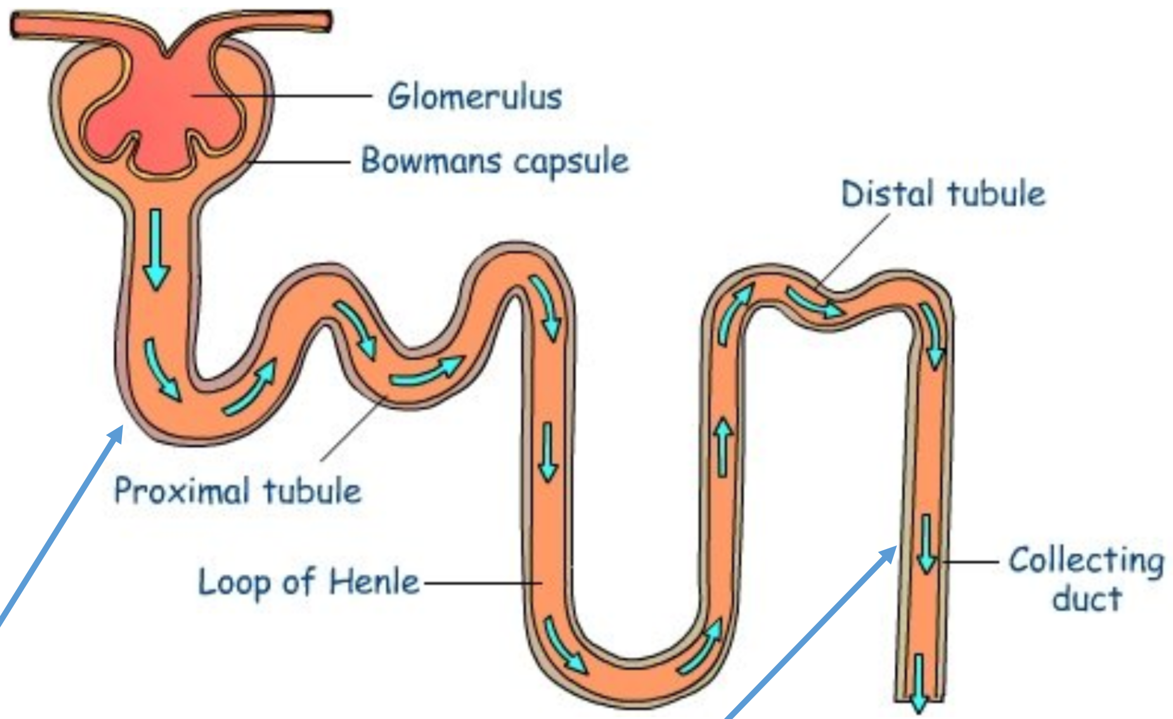
- PCO_2 correlates with $ETCO_2$ (end tidal CO_2)
- PCO_2 is partial pressure of dissolved CO_2 in blood
- $ETCO_2$ is partial pressure of CO_2 at the end of an exhaled breath
- Normal $ETCO_2$ is ~5 mm Hg less than PCO_2





Acid–Base Physiology: What Happens?

- Kidneys regulate HCO_3^-
- ~80-85% of HCO_3^- is reabsorbed in proximal convoluted tubule (PCT)
- But that is not enough
- New HCO_3^- is regenerated in collecting ducts
- Result of HCO_3^- reabsorption and regeneration → acid excretion
- HCO_3^- = **Metabolic** component



HCO_3^- reabsorption in PCT

HCO_3^- regeneration in distal nephron

Acid–Base Revealed

PCO_2

HCO_3^-

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pH

Acid–Base Physiology: What is Measured?

- **pH** – acidosis, alkalosis, normal
- **PCO_2** – partial pressure of dissolved CO_2
  - Measures respiratory component
- **HCO_3^-** – bicarbonate ion
  - Measures metabolic
  - Not independent of respiratory system (PCO_2)

EC8

Na	mmol/L
K	mmol/L
Cl	mmol/L
TCO2	mmol/L
BUN	mg/dL
Glu	mg/dL
Hct	%PCV
pH	
PCO2	mm Hg
HCO3	mmol/L
BEecf	mmol/L
AnGap	mmol/L
Hb	g/dL

CG8

pH	
PCO2	mm Hg
BEecf	mmol/L
HCO3	mmol/L
TCO2	mmol/L
Na	mmol/L
K	mmol/L
iCa	mmol/L
Glu	mg/dL
Hct	%PCV
Hb	g/dL

Acid–Base Physiology: What is Measured?

- **Base Excess (BE)** – amount of acid or base that must be added to oxygenated whole blood to restore pH to 7.4 (at 37°C & PCO_2 40 mm Hg)
  - Base = alkali
  - Measures metabolic
  - BE is independent of the respiratory system
  - Advantage over HCO_3^-

EC8	
Na	mmol/L
K	mmol/L
Cl	mmol/L
TCO2	mmol/L
BUN	mg/dL
Glu	mg/dL
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AnGap	mmol/L
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TCO2	mmol/L
Na	mmol/L
K	mmol/L
iCa	mmol/L
Glu	mg/dL
Hct	%PCV
Hb	g/dL

Acid–Base Physiology: What is Measured?

- **TCO$_2$** – total CO$_2$
  - Metabolic (not respiratory) component
  - Name is misleading
  - Majority of CO$_2$ is carried as HCO$_3^-$ in the blood

EC8	
Na	mmol/L
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K	mmol/L
iCa	mmol/L
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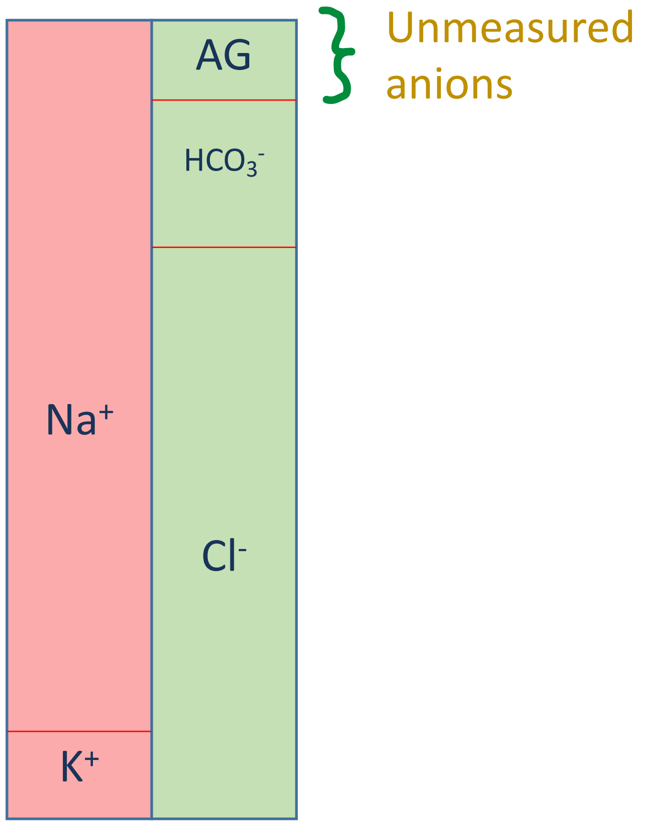
Hct	%PCV
Hb	g/dL

Acid–Base Physiology: What is Measured?

- **Anion Gap (AG)**
  - AG =(Na^+ + K^+) – (HCO_3^- + Cl^-)
  - Reflection of unmeasured anions and cations in the system, usually anions
    - **Cation** = positively charged ion
    - **Anion** = negatively charged ion
  - Electroneutrality → in reality, there is an equal number of cations and anions
  - But cations are more easily measured than anions that's why AG exists



Acid–Base Physiology: What is Measured?

Normal Values	Dogs	Cats
pH	7.41 (7.35-7.46)	7.39 (7.31-7.46)
PCO_2	37 (32-43)	31 (26-36)
HCO_3^-	22 (18-26)	18 (14-22)
Base Excess	-2 (+1 to -5)	-5 (-2 to -8)

Acid–Base Physiology: What is Measured?

- **"Rule of Four's"** – quick assessment

pH	7.**4** +/- 0.**4**
PCO_2	**40 +/- 4**
HCO_3^-	24 +/- **4**
Base Excess	-**4** to + **4**

FOUR

Four

Four

Acid–Base Revealed

PCO_2

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HCO_3^-

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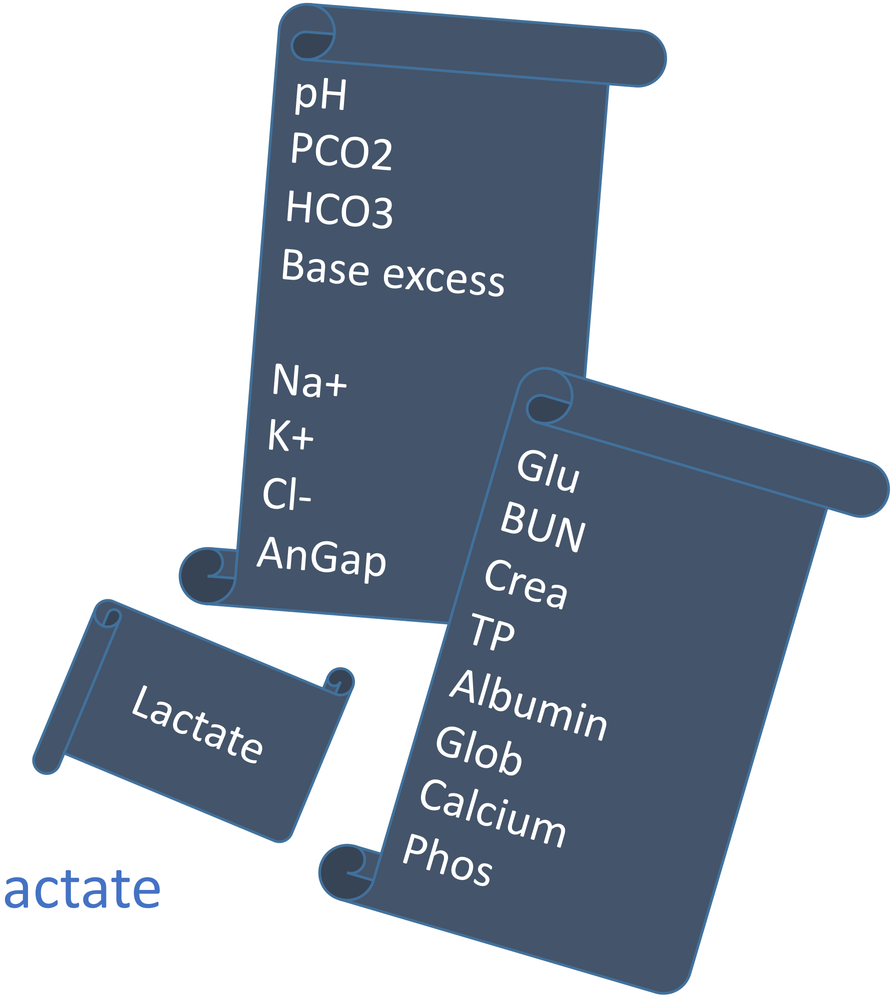
pH

Acid–Base Physiology: Acid-Base Analysis

- Tools used to analyze acid-base abnormalities
  - (1) **Traditional acid-base analysis** – most common
    - pH
    - PCO_2
    - HCO_3^-
    - Base excess
  - (2) Anion gap
    - Na^+, K^+, HCO_3^-, Cl^-
    - Unmeasured anions
  - (3) Semi-quantitative analysis
    - Free water/Na^+, Cl^-, albumin, phosphate, lactate



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Acid–Base Physiology: Acid-Base Analysis

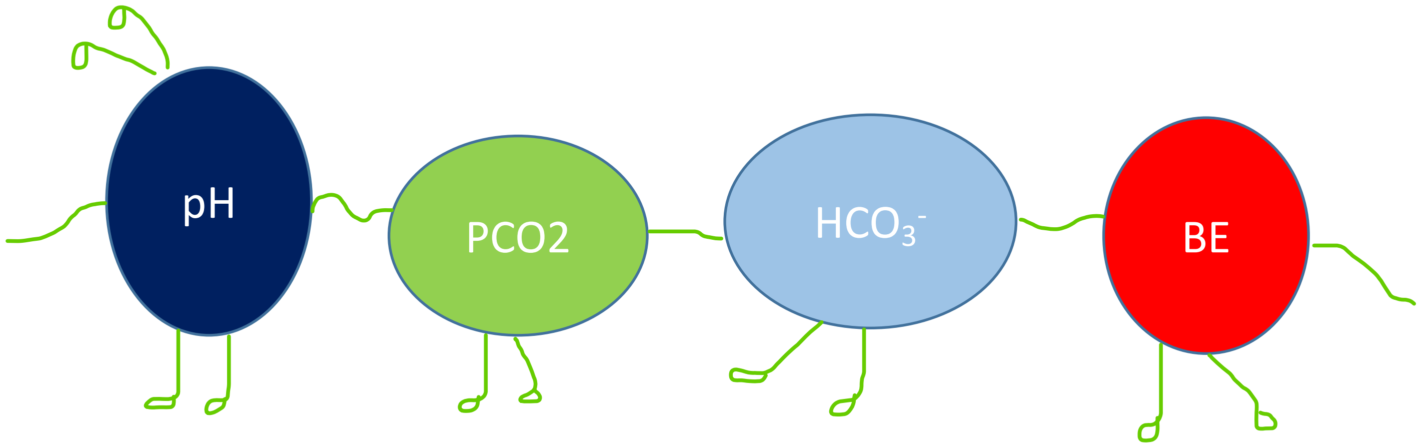
How to analyze acid-base?

1) Look at pH – "pH never lies"

- Acidosis – decreased pH
- Alkalosis – increased pH

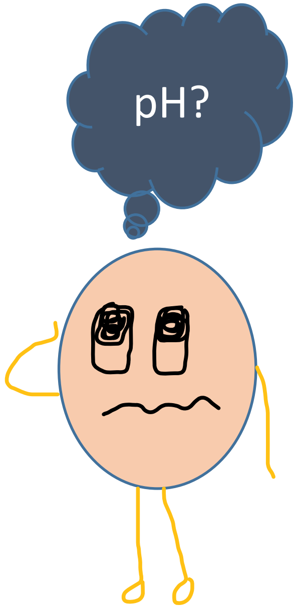
2) Look at PCO_2 – Respiratory component

- Acidosis – increased PCO_2
- Alkalosis – decreased PCO_2



Acid–Base Physiology: Acid-Base Analysis

How to analyze acid-base?



3) Look at HCO_3^- – Metabolic component

- Acidosis – decreased HCO_3^-
- Alkalosis – increased HCO_3^-

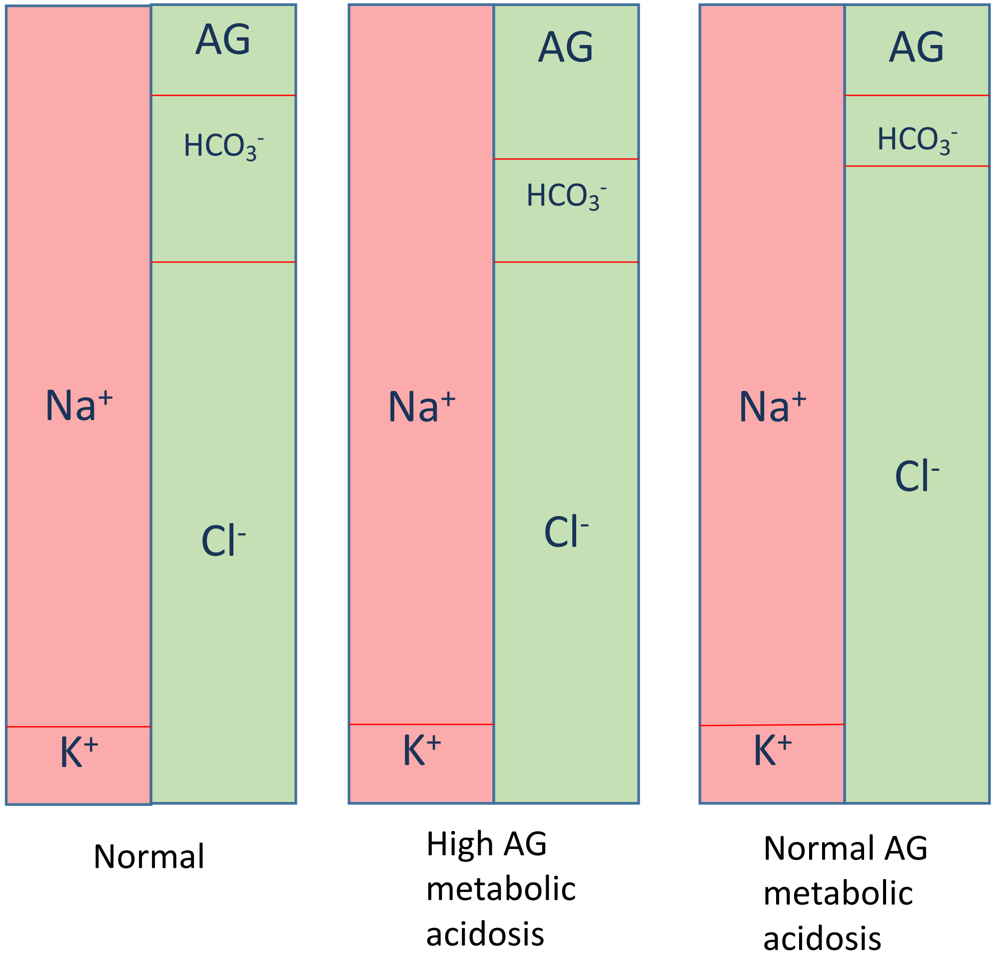
4) Look at BE – Metabolic component

- Acidosis – negative BE
- Alkalosis – positive BE

5) Define the primary process → which process is causing a change in the same direction as the pH? → PCO_2 or HCO_3^-?

Acid–Base Physiology: Acid-Base Analysis

- **Anion Gap (AG)**
  - Increase in AG is usually due to increase in unmeasured anions
  - High AG metabolic acidosis
    - Common anions (acids) contribute to high AG
    - Ketones, uremic acids, ethylene glycol, lactate
  - Normal AG metabolic acidosis
    - HCO_3^- loss replaced by Cl^-
    - Renal tubular acidosis, diarrhea



Acid–Base Physiology: Acid-Base Analysis

- Semi-quantitative acid-base analysis
  - Factors contributing to base excess and calculating their effects

Parameter	Shorthand Formula
1. Free water effect	(Measured Na^+ – Normal Na^+) / 4
Corrected chloride	Measured Cl^- x (Normal Na^+ / Measured Na^+)
2. Chloride effect	Normal Cl^- – Corrected Cl^-
3. Albumin effect	(Normal albumin – Measured albumin) x 4
4. Phosphate effect	(Normal phosphate – Measured phosphate) / 2
5. Lactate effect	Measured lactate x [–1]
Sum of effects	Free water effect + Chloride effect + Albumin effect + Phosphate effect + Lactate effect
Unmeasured ion effect	**Base excess – sum of effects**

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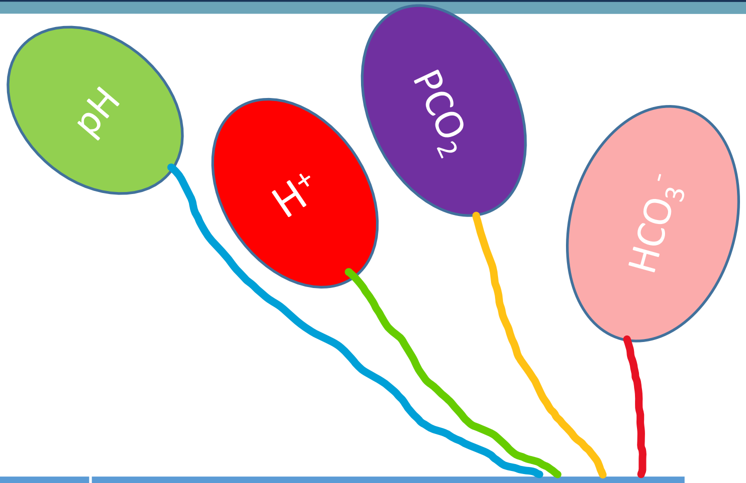
Acid–Base Disorders



- There are 4 types of acid-base disorders

Acid-base disturbance	pH	Primary Disorder	Compensation
Metabolic acidosis	↓ Decreased	↓ Decreased HCO_3^-	↓ Decreased PCO_2
Metabolic alkalosis	↑ Increased	↑ Increased HCO_3^-	↑ Increased PCO_2
Respiratory acidosis	↓ Decreased	↑ Increased PCO_2	↑ Increased HCO_3^-
Respiratory alkalosis	↑ Increased	↓ Decreased PCO_2	↓ Decreased HCO_3^-

Acid–Base Disorders: Metabolic Acidosis

- **Causes of metabolic acidosis – common, 43% of small animals**

Salicylic acid
Ketones
Uremia
L-Lactic acidosis
Ethylene glycol

OR

Diabetic ketoacidosis
Uremia
Ethylene glycol
L-Lactic acidosis

Renal or **GI** HCO_3^- loss (diarrhea)
Addison's disease
Hypoalbuminemia

pH	Decreased
Primary	Decreased HCO_3^-
Compensation	Decreased PCO_2

Acid–Base Disorders: Metabolic Alkalosis

- **Causes of metabolic alkalosis – least common (15%)**
  - Usually via chloride (Cl^-) loss

GI obstruction (sequestration/vomiting)

NG tube suctioning

Loop diuretics (furosemide)

Mineralocorticoid excess (in Cushing's)

Hyperaldosteronism

pH	Increased
Primary	Increased HCO_3^-
Compensation	Increased PCO_2

Acid–Base Disorders: Respiratory Acidosis

- **Causes of respiratory acidosis**
  - Imbalance of CO_2 production and alveolar ventilation

Airway obstruction

Respiratory center depression (brain)

Increased CO_2 & reduced ventilation (CPA, heat stroke)

Neuromuscular disease

Pulmonary disease

Inadequate mechanical ventilation

Chest wall disease

pH	Decreased
Primary	Increased PCO_2
Compensation	Increased HCO_3^-

Acid–Base Disorders: Respiratory Alkalosis

- **Causes of respiratory alkalosis**
  - Blowing off CO_2 (increased RR/effort)

Pain, fear anxiety (panting)

Hypoxemia

Pulmonary disease

Centrally mediated

Overzealous mechanical ventilation

pH	Increased
Primary	Decreased PCO_2
Compensation	Decreased HCO_3^-

Acid–Base Disorders: Compensation

Expected Compensatory Changes to Primary Acid-Base Disorders		
Primary disorder	**Primary change**	**Expected Compensation**
Metabolic acidosis	↓ HCO_3^-	↓ PCO_2 of 0.7 mm Hg per 1 mEq/L ↓ in HCO_3^- +/- 3
Metabolic alkalosis	↑ HCO_3^-	↑ PCO_2 of 0.7 mm Hg per 1 mEq/L ↑ in HCO_3^- +/- 3
Respiratory acidosis–acute	↑ PCO_2	↑ HCO_3^- of 0.15 mEq/L per 1 mm Hg ↑ PCO_2 +/- 2
Respiratory acidosis–chronic	↑ PCO_2	↑ HCO_3^- of 0.35 mEq/L per 1 mm Hg ↑ PCO_2 +/- 2
Respiratory alkalosis–acute	↓ PCO_2	↓ HCO_3^- of 0.25 mEq/L per 1 mm Hg ↓ PCO_2 +/- 2
Respiratory alkalosis–chronic	↓ PCO_2	↓ HCO_3^- of 0.55 mEq/L per 1 mm Hg ↓ PCO_2 +/- 2

Acid–Base Disorders: Tips

PCO_2

pH

- **Compensation not as expected?**
  - Mixed acid-base disorder
- **Compensation normalizes pH**
  - It does not correct the underlying disorder

pH:

Metabolic → Same (High or Low)

Respiratory → Opposite

i. e. ↓ pH, ↓ HCO_3^-

↓ pH, ↑ PCO_2

HCO_3^-

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Acid–Base Physiology: Review

pH

Acidosis

Metabolic

- Diabetic ketoacidosis
- Uremia
- Ethylene glycol
- Lactic acidosis
- GI bicarb loss
- Renal tubular acidosis
- Addison's disease

Respiratory

- Airway obstruction
- Respiratory center depression (brain)
- Increased CO_2 & reduced ventilation (CPA, heat stroke)
- Neuromuscular disease
- Pulmonary disease
- Inadequate mechanical ventilation
- Chest wall disease

Alkalosis

Metabolic

- GI obstruction (sequestration /vomiting)
- NG tube suctioning
- Loop diuretics (furosemide)
- Mineralocorticoid excess (in Cushing's)
- Hyperaldosteronism

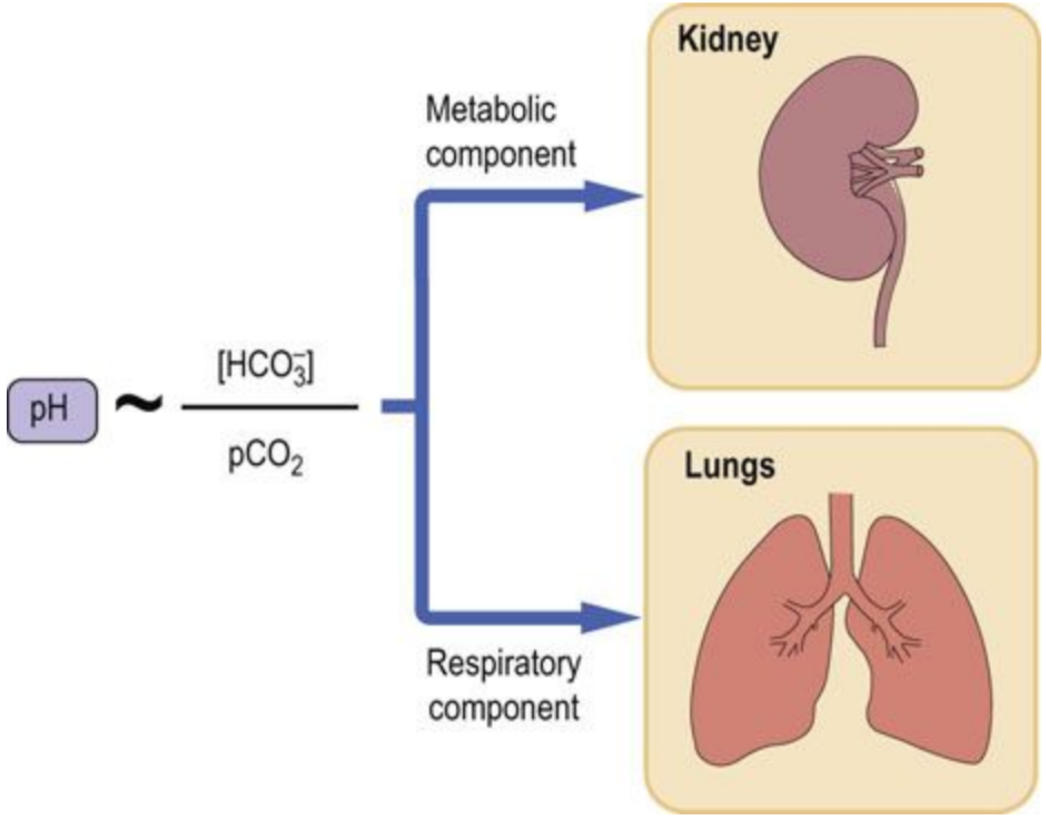
Respiratory

- Pain, fear anxiety (panting)
- Hypoxemia
- Pulmonary disease
- Centrally mediated
- Overzealous mechanical ventilation

Acid–Base Physiology: Review

- Acid-base balance
  - Lungs clear CO_2
  - Kidneys reabsorb/regenerate HCO_3^- used to buffer H^+ ions

- Components of acid-base
  - Respiratory – PCO_2
  - Metabolic – HCO_3^-



Acid–Base Disorders

Metabolic acidosis

- Pyometra
  - 12-year-old FS German Shepherd
  - Polydipsia, polyuria, discomfort

  - pH:
  - PCO_2:
  - HCO_3^-:
  - BE:
  - Acid-base disorder:
  - Compensation:

EC8	
Na	151 mmol/L
K	3.8 mmol/L
Cl	131 mmol/L
TCO2	12 mmol/L
BUN	<3 mg/dL
Glu	161 mg/dL
Hct	30 %PCV
pH	7.275
PCO2	25.1 mm Hg
HCO3	11.6 mmol/L
BEecf	-15 mmol/L
AnGap	12 mmol/L
Hb	10.2 g/dL

Normals
Na 142-150
K 3.4-4.9
Cl 106-127
TCO2 17-25
BUN 10-26
Glu 60-115
Hct 35-50

pH 7.35-7.45
PCO2 35-38
HCO3 15-23
Beecf -5 – 0
AnGap 8-25
Hb 12-17

Acid–Base Disorders

Metabolic acidosis

- Renal failure
  - 10-year-old MN Sheltie
  - Anorexia, vomiting, weight loss

  - pH:
  - PCO_2:
  - HCO_3^-:
  - BE:
  - Acid-base disorder:
  - Compensation:

EC8	
Na	139 mmol/L
K	3.9 mmol/L
Cl	118 mmol/L
TCO2	12 mmol/L
BUN	110 mg/dL
Glu	85 mg/dL
Hct	24 %PCV
pH	7.157
PCO2	31.9 mm Hg
HCO3	11.3 mmol/L
BEecf	-17 mmol/L
AnGap	14 mmol/L
Hb	8.2 g/dL

Normals
Na 142-150
K 3.4-4.9
Cl 106-127
TCO2 17-25
BUN 10-26
Glu 60-115
Hct 35-50

pH 7.35-7.45
PCO2 35-38
HCO3 15-23
Beecf -5 – 0
AnGap 8-25
Hb 12-17

Acid–Base Disorders

Metabolic acidosis

- Starvation
  - 8-year-old MN DSH
  - Missing for 5 months, severe weight loss

  - pH:
  - PCO_2:
  - HCO_3^-:
  - BE:
  - Acid-base disorder:
  - Compensation:

CG8

pH	7.011
PCO2	38.1 mm Hg
BEecf	-21 mmol/L
HCO3	9.6 mmol/L
TCO2	11 mmol/L
Na	136 mmol/L
K	6.9 mmol/L
iCa	0.95 mmol/L
Glu	75 mg/dL
Hct	24 %PCV
Hb	8.2 g/dL

Normals
pH 7.35-7.45
PCO2 35-38
BEecf -5 – 0
HCO3 15-23
TCO2 17-25

Na 142-150
K 3.4-4.9
iCa 1.12-1.40
Glu 60-115
Hct 35-50
Hb 12-17

Acid–Base Disorders

Metabolic acidosis

- Diabetic ketoacidosis
  - 8-year-old MN Chihuahua
  - Vomiting, anorexia

  - pH:
  - PCO_2:
  - HCO_3^-:
  - BE:
  - Acid-base disorder:
  - Compensation:

EC8	
Na	141 mmol/L
K	3.2 mmol/L
Cl	109 mmol/L
TCO2	11 mmol/L
BUN	37 mg/dL
Glu	565 mg/dL
Hct	47 %PCV
pH	7.270
PCO2	27.3
HCO3	9.2
BEecf	-15
AnGap	25
Hb	15.8

Normals
Na 142-150
K 3.4-4.9
Cl 106-127
TCO2 17-25
BUN 10-26
Glu 60-115
Hct 35-50
pH 7.35-7.45
PCO2 35-38
HCO3 15-23
Beecf -5 – 0
AnGap 8-25
Hb 12-17

Acid–Base Disorders

Metabolic acidosis

- Hypokalemia, weakness
  - 15-year-old MN Mix breed dog
  - Anorexia, weakness, obtunded, weight loss, hypokalemia

- pH:
- PCO_2:
- HCO_3^-:
- BE:
- Acid-base disorder:
- Compensation:

CG8	
pH	7.110
PCO2	39 mm Hg
BEecf	-9 mmol/L
HCO3	9 mmol/L
TCO2	11 mmol/L
Na	141 mmol/L
K	2.3 mmol/L
iCa	1.10 mmol/L
Glu	68 mg/dL
Hct	31 %PCV
Hb	9.9 g/dL

Normals
pH 7.35-7.45
PCO2 35-38
BEecf -5 – 0
HCO3 15-23
TCO2 17-25

Na 142-150
K 3.4-4.9
iCa 1.12-1.40
Glu 60-115
Hct 35-50
Hb 12-17

Acid–Base Disorders

Metabolic alkalosis

- Pyloric outflow obstruction
  - 5-year-old MN Labrador
  - Vomiting, fluid-filled stomach on abdominal radiographs

- pH:
- PCO_2:
- HCO_3^-:
- BE:
- Acid-base disorder:
- Compensation:

EPOC	
pH	7.474
PCO2	46.5 mm Hg
BEecf	10.5 mmol/L
HCO3	34.1 mmol/L
TCO2	35.6 mmol/L
Na	149 mmol/L
K	3.2 mmol/L
Cl	101 mmol/L
iCa	1.28 mmol/L
Glu	125 mg/dL
Hct	42 %PCV
Hb	16.1 g/dL

Normals
pH 7.35-7.45
PCO2 35-38
BEecf -5 – 0
HCO3 15-23
TCO2 17-25

Na 142-150
K 3.4-4.9
Cl 106-127
iCa 1.12-1.40
Glu 60-115
Hct 35-50
Hb 12-17

Acid–Base Disorders

Respiratory acidosis

- Pneumonia
  - 13-year-old FS Mix breed dog
  - Labored breathing, vomiting, diarrhea

- pH:
- PCO_2:
- HCO_3^-:
- BE:
- Acid-base disorder:
- Compensation:

CG8	
pH	7.098
PCO2	75.7 mm Hg
BEecf	-6 mmol/L
HCO3	23.4 mmol/L
TCO2	26 mmol/L
Na	144 mmol/L
K	4.9 mmol/L
iCa	1.50 mmol/L
Glu	148 mg/dL
Hct	36 %PCV
Hb	12.2 g/dL

Normals
pH 7.35-7.45
PCO2 35-38
BEecf -5 – 0
HCO3 15-23
TCO2 17-25

Na 142-150
K 3.4-4.9
iCa 1.12-1.40
Glu 60-115
Hct 35-50
Hb 12-17

Acid–Base Disorders

Respiratory acidosis

- Feline asthma
  - 10-year-old MN Persian
  - Respiratory distress

  - pH:
  - PCO_2:
  - HCO_3^-:
  - BE:
  - Acid-base disorder:
  - Compensation:

EC8	
Na	148 mmol/L
K	3.5 mmol/L
Cl	109 mmol/L
TCO2	34 mmol/L
BUN	23 mg/dL
Glu	150 mg/dL
Hct	37 %PCV
pH	7.345
PCO2	59.7 mm Hg
HCO3	32.6 mmol/L
BEecf	7 mmol/L
AnGap	9 mmol/L
Hb	12.6 g/dL

Normals
Na 147-162
K 2.9-4.2
Cl 112-129
TCO2 16-25
BUN 15-34
Glu 60-130
Hct 24-40

pH 7.25-7.40
PCO2 33-51
HCO3 13-25
Beecf -5–+2
AnGap 8-25
Hb 8-13

Acid–Base Disorders

Respiratory alkalosis

- Pneumonia
  - 5-month-old Shepherd puppy
  - Shallow breathing, coughing

- pH:
- PCO_2:
- HCO_3^-:
- BE:
- Acid-base disorder:
- Compensation:

EC8	
Na	143 mmol/L
K	3.8 mmol/L
Cl	116 mmol/L
TCO2	21 mmol/L
BUN	12 mg/dL
Glu	118 mg/dL
Hct	34 %PCV
pH	7.460
PCO2	28 mm Hg
HCO3	20 mmol/L
BEecf	8 mmol/L
AnGap	12 mmol/L
Hb	11.3 g/dL

Normals
Na 142-150
K 3.4-4.9
Cl 106-127
TCO2 17-25
BUN 10-26
Glu 60-115
Hct 35-50

pH 7.35-7.45
PCO2 35-38
HCO3 15-23
Beecf -5 – 0
AnGap 8-25
Hb 12-17

Acid–Base Disorders

Mixed acid-base disorder

- Hepatopathy, GI
  - 12-year-old MN Yorkie
  - Hematochezia, vomiting

  - pH:
  - PCO_2:
  - HCO_3^-:
  - BE:
  - Acid-base disorder:
  - Compensation:

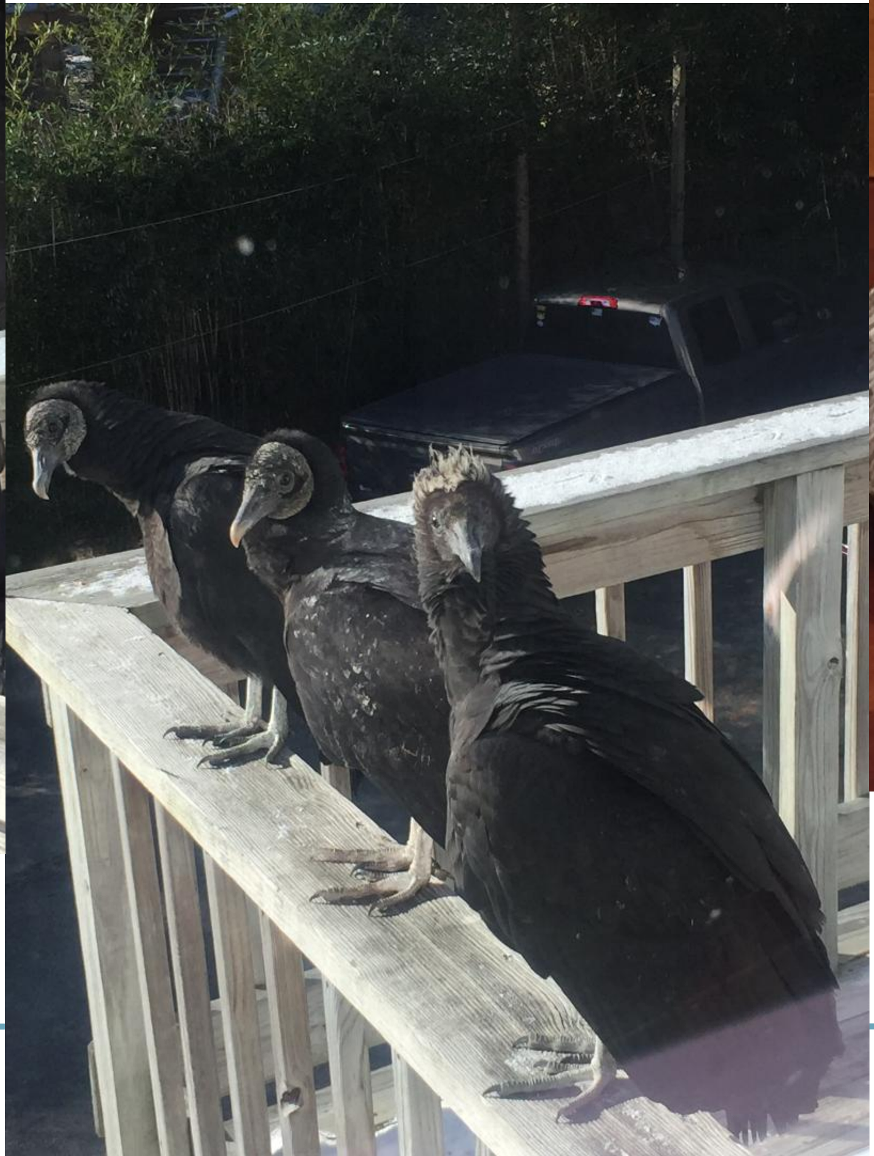
CG8	
pH	7.056
PCO2	50.6 mm Hg
BEecf	-16 mmol/L
HCO3	14.2 mmol/L
TCO2	16 mmol/L
Na	151 mmol/L
K	3.5 mmol/L
iCa	1.39 mmol/L
Glu	117 mg/dL
Hct	71 %PCV
Hb	24.1 g/dL

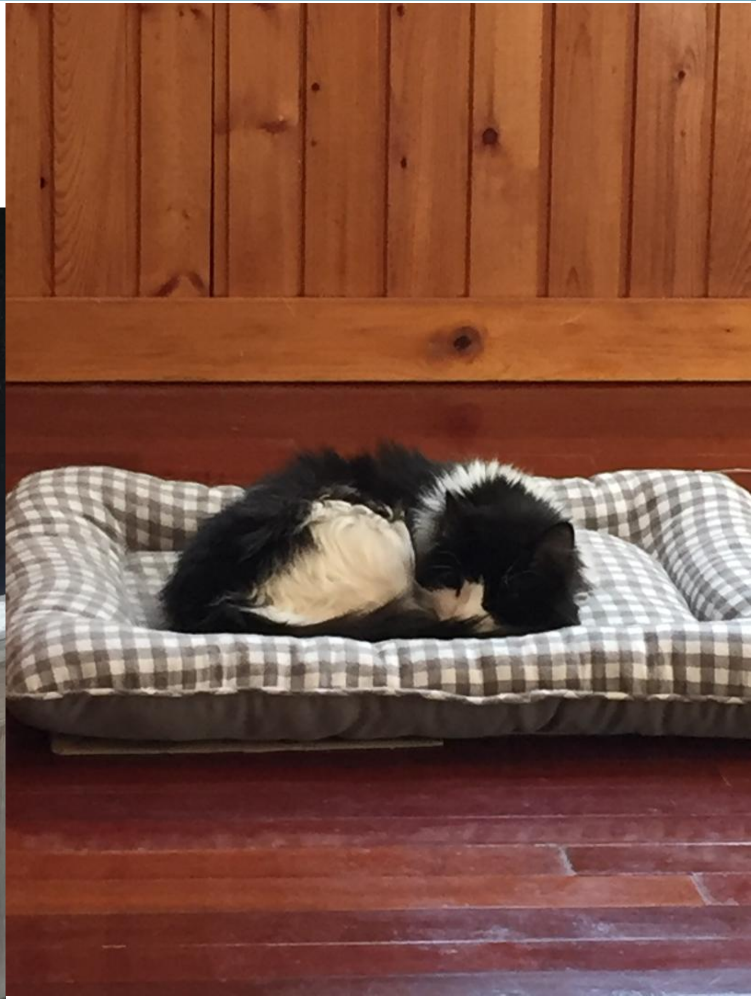
Normals
pH 7.35-7.45
PCO2 35-38
BEecf -5 – 0
HCO3 15-23
TCO2 17-25

Na 142-150
K 3.4-4.9
iCa 1.12-1.40
Glu 60-115
Hct 35-50
Hb 12-17

Questions?

Vultures in my window





Meanwhile….

MEDVET

Resources

- Fluid, Electrolyte and Acid-Base Disorders in Small Animal Practice. 4th Ed. DiBartola SP, Ed. Elsevier Saunders 2012.
- Small Animal Critical Care Medicine. 2nd Ed. Silverstein DC, Hopper K, Eds.
- Physiology, Acid Base Balance. Hopkins E, Sharma S. Stat Pearls [Internet]. June 16, 2019. https://www.ncbi.nlm.nih.gov/books/NBK507807/
- An Introduction to Acid-Base Analysis. Kuo K. IVECCS 2019.
- Relating oxygen partial pressure, saturation and content: the haemoglobin–oxygen dissociation curve. Collins JA, et al. Breathe (Sheff). 2015 Sep; 11(3): 194–201.
- What is the "Carbonic acid-bicarbonate" buffer system? https://socratic.org/questions/what-is-the-carbonic-acid-bicarbonate-buffer-system-1
- Demonstration by Professor Diane O'Dowd of how the carbonic acid-bicarbonate buffer works: https://vimeo.com/20298747
- Picture of homeostasis (balance): https://www.facebook.com/FoxRunEquineCenter/photos/a.212079865495274/1464759673560614/?type=3&theater
- Picture of pH tubes: https://www.thoughtco.com/definition-of-ph-in-chemistry-604605
- Picture of litmus paper strips: https://www.123rf.com/photo_116268440_ph-scale-acid-base-balance-scale-for-chemical-analysis-acid-base-colorful-graph-for-test.html
- Picture of pH range: https://www.chem.purdue.edu/courses/chm333/Spring%202013/Lectures/Spring%202013%20Lecture%205.pdf
- Picture of brain: https://www.sciencemag.org/news/2017/04/study-finds-some-significant-differences-brains-men-and-women
- Picture of mitochondrion: https://www.genengnews.com/news/removal-of-damaged-mitochondria-helps-treat-chronic-inflammatory-disease/
- Picture of heart: https://www.123rf.com/photo_92668595_stock-vector-hand-drawn-vector-anatomic-heart-colored-isolated-on-pink-background.html
- Picture of ECG: https://www.acadoodle.com/articles/top-5-tips-to-avoid-misinterpreting-the-ecg-ekg
- Picture of buffers: https://www.austincc.edu/apreview/EmphasisItems/Electrolytefluidbalance.html
- Picture of lungs: https://www.riversidehealthcare.org/services/cancer-institute/cancers-we-treat/lung-cancer/
- Picture of kidneys: https://www.vectorstock.com/royalty-free-vector/human-kidneys-isolated-on-white-background-vector-26219833
- Picture of lungs blowing off CO2: https://www.labpedia.net/bicarbonate-level-hco3-acid-base-balance/
- Picture of gas exchange: https://commons.wikimedia.org/wiki/File:Alveoli.svg
- Picture of cat lungs: https://www.merckvetmanual.com/cat-owners/lung-and-airway-disorders-of-cats/introduction-to-lung-and-airway-disorders-of-cats
- Picture of nephron: https://www.researchgate.net/figure/Shows-the-structure-of-the-nephron-which-filters-waste-from-the-bodys-blood-supply_fig18_44960293
- Picture of AG single column: https://commons.wikimedia.org/wiki/File:Anion_Gap.svg
- Picture of AG: https://commons.wikimedia.org/wiki/File:Anion_Gap.svg
- Picture of acid-base overview: https://doctorlib.info/medical/biochemistry/27.html
- Picture of metabolic and respiratory component: https://doctorlib.info/medical/biochemistry/27.html