

## CBC and Biochemistry Profiles Interpretation

อ.น.สพ.ดร. เกษญา รุ่งภูประดิษฐ์  
คณะสัตวแพทยศาสตร์ มหาวิทยาลัยเทคโนโลยีมหานคร

Vet M.U.T. Journal Club

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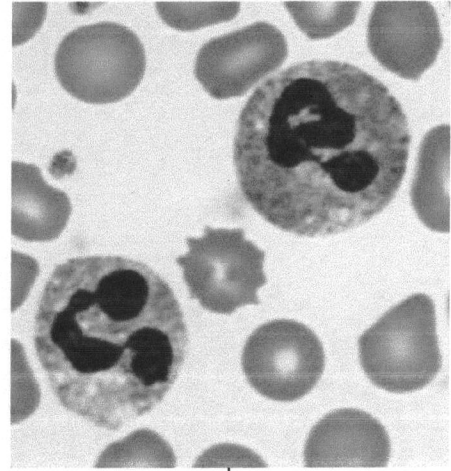
## Leukogram: What are we looking for?

- Inflammation?
- Stress?
- Necrosis?
- Hypersensitivity?
- Toxemia?

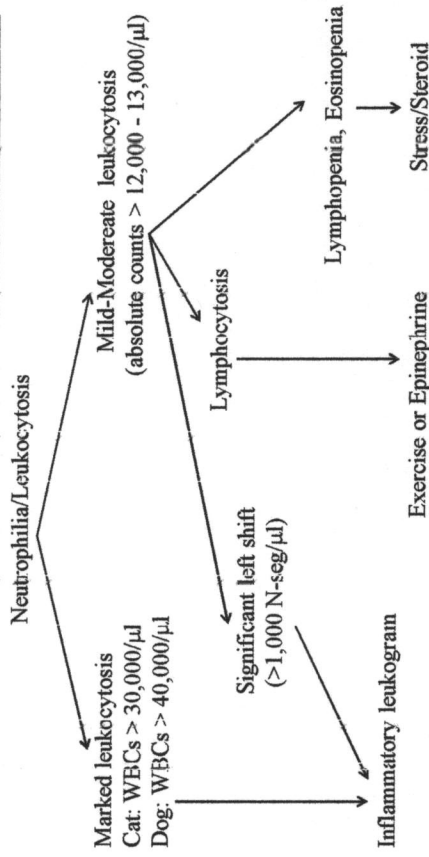
## Neutrophilia: Cause

- Physiologic or epinephrine-induced
- Corticosteroid- or stress-induced
- Hemorrhage or Hemolytic
- Inflammation
  - Acute inflammation
  - Chronic inflammation
  - Overwhelming inflammation
- Granulocytic leukemia
- Inherited granulocyte defects

## Neutrophils



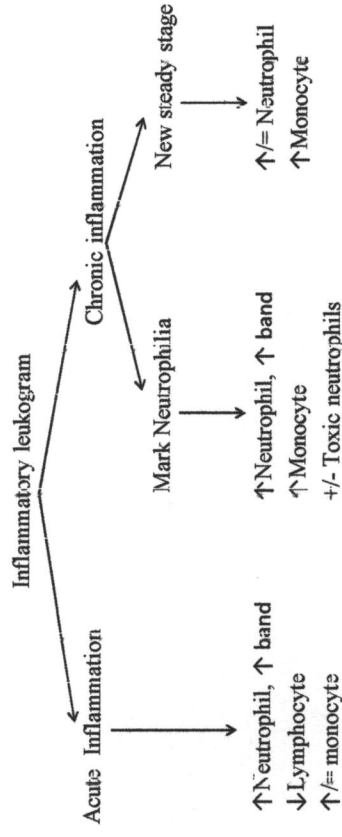
## Leukocytosis/Neutrophilia



## Classic Stress leukogram pattern

- moderate leukocytosis (Dog: 15,000 – 25,000/ $\mu$ l, Cat: 22,000/ $\mu$ l) with mature neutrophilia
- lymphopenia
- +/- eosinopenia
- Dog: mild to moderate monocytosis (e.g., 2,500/ $\mu$ l)
- Nuclear hypersegmentation of neutrophils (right shift)
- The values return to baseline in 24 hours.

## Inflammatory leukogram



## Neutrophilia of Acute Inflammation

- Leukogram finding
  - ↑ band cells (a regenerative left shift)
  - Lymphopenia (animals normally get stress during acute phase)
  - variable monocytosis
- marrow release of segmented and band neutrophils into blood > migration to tissues.
- When present, the monocytosis reflects demand for phagocytosis / tissue necrosis.

## Chronic inflammation

### Mark neutrophilia

- Leukocytosis (1.50-200,000/ $\mu$ l or more)
- Neutrophilia with a left shift
- +/-Toxic neutrophils
- Monocytosis**
- Hyperglobulinemia and anemia of chronic**
- Chronic suppurative lesions (eg, pyometra, abscesses, pyothorax, pyoderma)

### New steady stage

- Normal to slightly increase neutrophile count without left shift
- Normal lymphocyte count reflects the counterbalancing effects of stress and antigenic stimulation on lymphocyte numbers.
- Monocytosis** reflects demand for phagocytosis/tissue necrosis.

## Hemolytic or Hemorrhagic Anemias

- Neutrophilias with left shift frequently occur in animals with immune-mediated hemolytic anemia.
- Leukocytosis can be marked ( $>50,000/\mu$ l).
- Mature neutrophilia occurs 3 hours following acute hemorrhage

## Chronic Granulocytic Leukemia

- Marked neutrophilic leukocytosis ( $>80,000/\mu$ l)
- Very young neutrophil precursors (promyelocytes and myeloblasts) may be seen.
- Thrombocytopenia and/or nonregenerative anemia are observed in varying degrees.
- Hepatomegaly and/or splenomegaly may be present due to neoplastic infiltration.

## Neutropenia

## Neutropenia: Cause

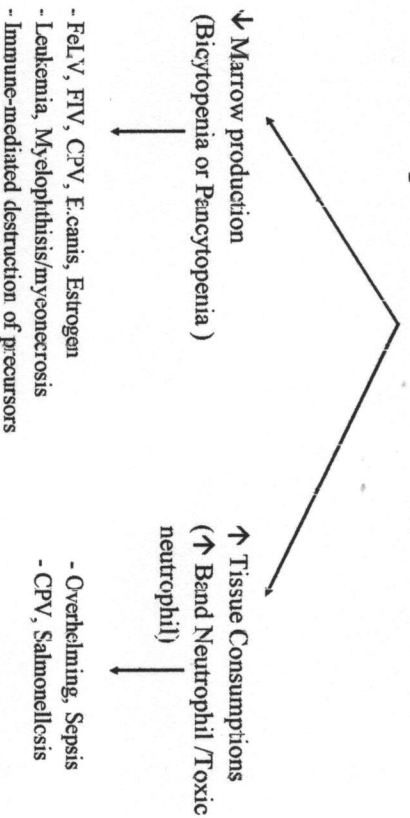
- Acute demand or consumption in tissue
- Decreased marrow production
- Ineffective granulopoiesis (dysgranulopoiesis)
- Increased margination from the circulating neutrophil pool to the marginal neutrophil pool (Anaphylaxis or Endotoxemia)

## Major Causes of Neutropenia

Consumption of neutrophils	ANIMAL AFFECTED
Overwhelming sepsis/endotoxemia*	Dogs/cats
Parvovirus enteritis*	Dogs/cats
Salmonellosis*	Dogs/cats
Immune-mediated	Cats
<b>Bone marrow suppression</b>	
FLV, FIV*	Cats
Parvovirus*	Dogs/cats
Ehrlichiosis	Dogs
Bone marrow toxicity	Dogs/cats
Estrogen (endogenous/exogenous)	Dogs
Phenylbutazone	Dogs/cats
Chemotherapy	Dogs/cats
Leukemia*	Dogs/cats
Myelophthisis/myelonecrosis	Dogs/cats
Immune-mediated destruction	Dogs/cats

## Leukopenia/Neutropenia

↓ Neutrophils → ↓ Total white blood cells count



## Neutropenia (Acute Tissue Demand)

- Laboratory features include
  - ↓ neutrophil numbers with left shift (Degenerative left shift)
  - Lymphopenia
  - Toxic neutrophils
  - +/- monocytosis
- Suggest inability of marrow production to keep pace with tissue demand.
- Left shift indicates depletion of marrow neutrophil storage pools.
- Lymphopenia reflects stress.
- When present, monocytosis indicates tissue necrosis/demand for phagocytosis.



## Neutropenia (Acute Tissue Demand)

- Neutrophil counts of less than 2,000 cells/ $\mu$ l require monitoring the patient for sepsis.
- Sepsis is presumed to be present if the patient has less than 500 neutrophils/ $\mu$ l and is febrile
- Chemotherapy with myelosuppressive agents should be discontinued if the neutrophil count less than 2,500 cells/ $\mu$ l

### General Patterns of Leukocyte Responses

	WBC	Seg	Band	Lymph	Mono	Eos
Acute Inflammation	↑	↑	↑	↓/=	Variable	Variable
Chronic Inflammation	↑/=	↑/=	↑/=	↑/=	↑	Variable
Overwhelming Inflammation	↓/=	↓/=	↑	↓/=	Variable	Variable
Excitement leukocytosis	↑	↑ (dog) ↑/= (cat)	=	= (dog) ↑ (cat)	=	=
Stress leukogram	↑	↑	=	↓	↑/=	↓/=

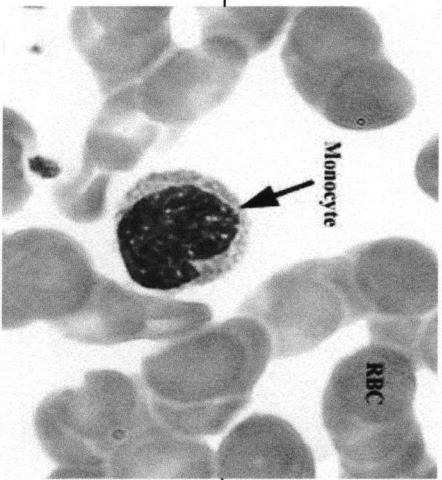
## Is there evidence of systemic toxemia?

- The presence of toxic neutrophils on the blood film indicates systemic toxemia
- Systemic toxemia is most commonly associated with bacterial infections.
- However, other causes, such as extensive tissue necrosis, must also be considered.

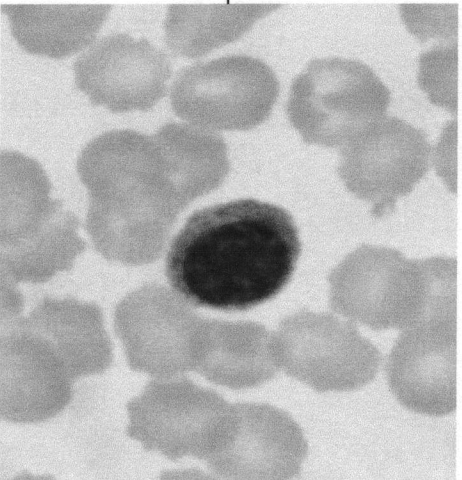
## Leukogram Finding Considered Poor Prognostic Indicators

Finding	Reason for poor prognosis
Degenerative left shift	Tissue demand exceeds bone marrow's production of neutrophils or cause inadequate time for maturation of neutrophils
Leukopenia	Tissue demand exceeds bone marrow's production of neutrophils
Leukemoid reaction	Even excessive neutrophils can not correct the cause (WBC count > 100,000 cells/ $\mu$ l)
Significant toxic neutrophils	Moderate to many, moderate to severely toxic neutrophils indicate toxemia, often gram negative sepsis
Severe or persistent lymphopenia	Indicates severe stress or lack of relief from stress

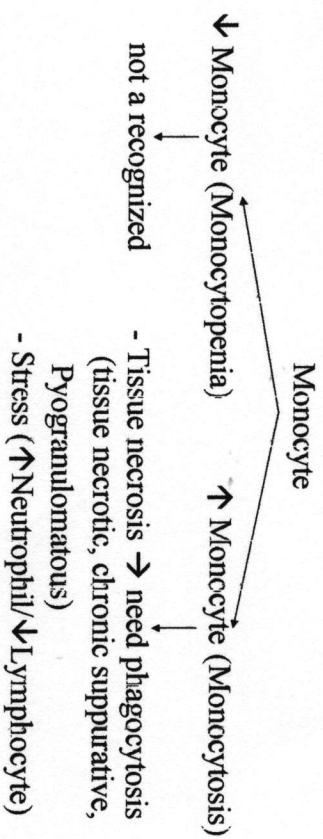
# Monocyte



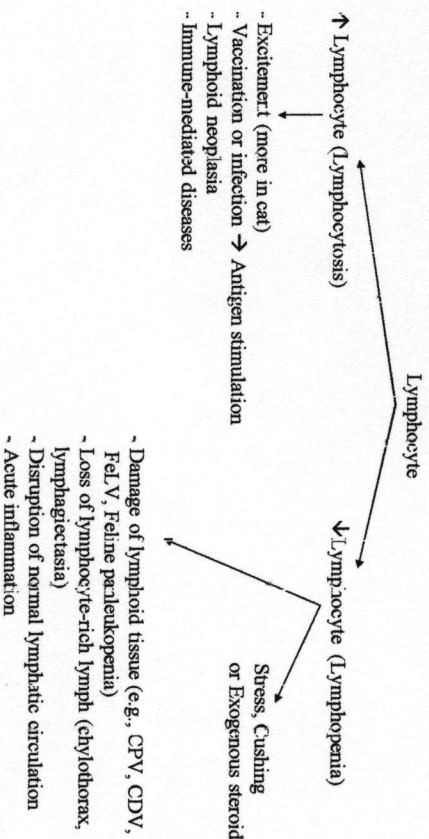
# Lymphocyte



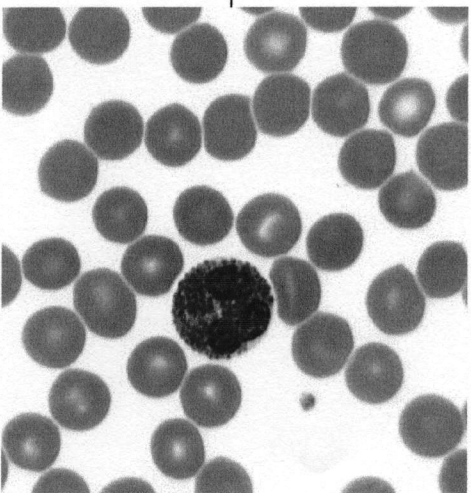
# Monocyte



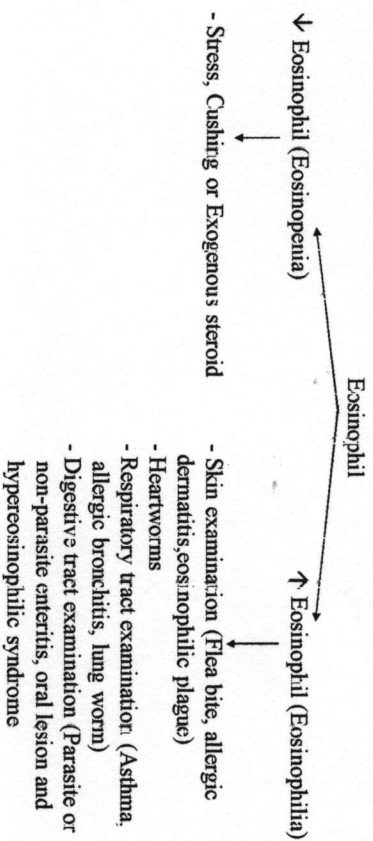
# Lymphocyte



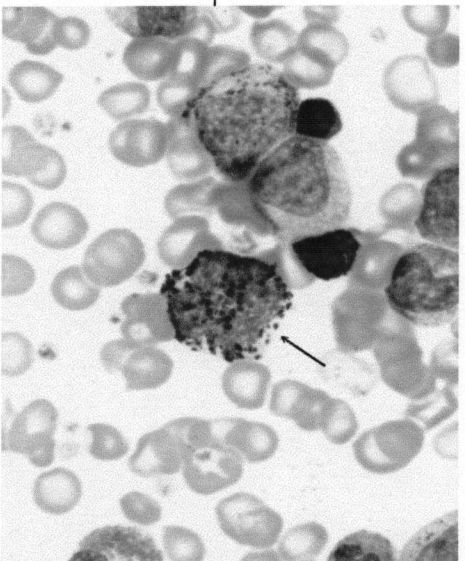
# Eosinophil



# Eosinophil



# Basophilia

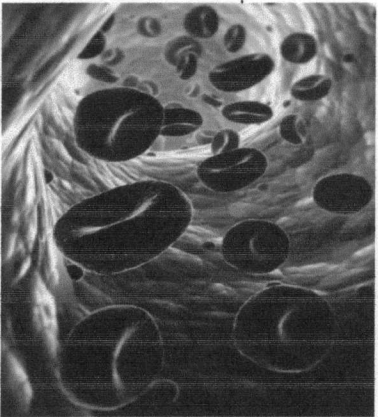


# Basophilia (>2%)

- Mast cell tumor
- Associate with lipidemia
- Hypersensitivity reaction



## Red Blood Cells



### Reticulocyte index

- Step1. Effect of hydration to PCV
  - Dehydration → ↑ PP, ↑ PCV
- Step 2. Evaluate the bone marrow's response
  - Reticulocyte percentage count
- Step3. %Reticulocyte → CRP
  - $CRP = \% \text{reticulocyte} \times \text{patient's PCV}$   
normal PCV
- Step4. CRP → RI (only in dogs)
  - $RI = \frac{CRP}{\text{life span of reticulocytes}}$

### Severity Anemia

	Canine	Feline
Mild	30-37%	20-26%
Moderate	20-29%	14-19%
Severe	13-19%	10-13%
Very severe	< 13%	< 10%

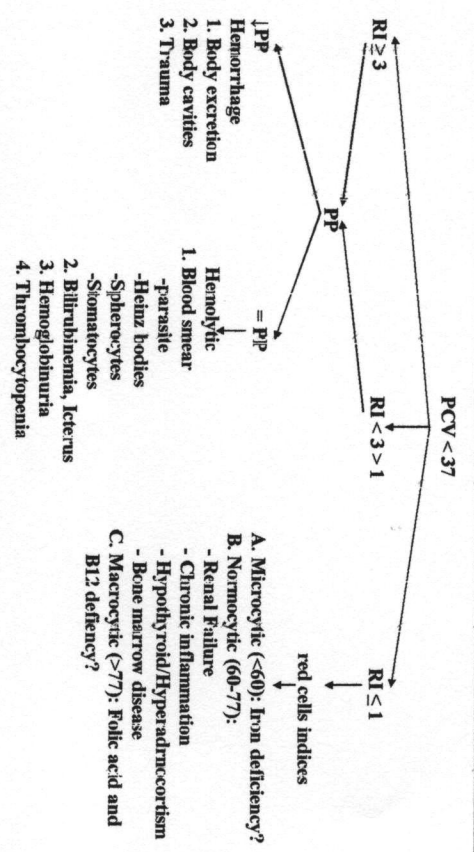
### Reticulocyte Index

RETICULOCYTE	EXPECTED LIFE SPAN (DAYS)
45	1.0
35	1.5
25	2.0
15	2.5

### HEMATOCRIT

45	1.0
35	1.5
25	2.0
15	2.5

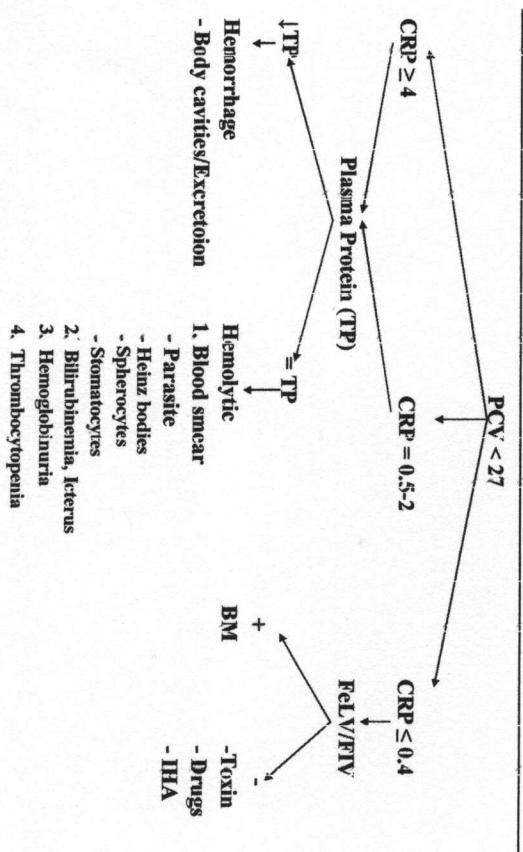

### Diagnosis plan for canine anemia



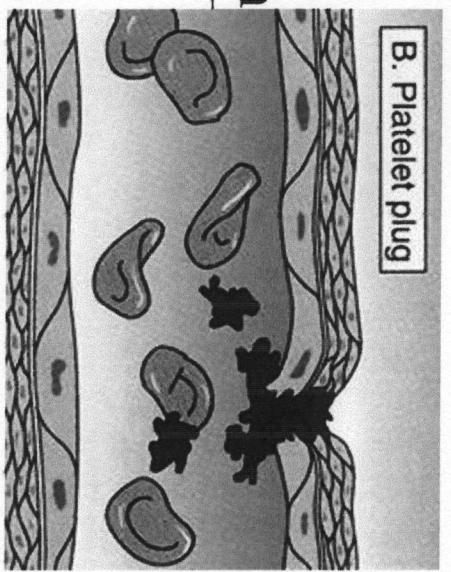

### ข้อควรระวัง

- Internal Blood loss → normal TP
- External blood loss → ↓ PCV
  - 1-3 days → ↓ Reticulocyte count
  - 3-5 days → ↓ Reticulocyte count


### Diagnosis plan for feline anemia



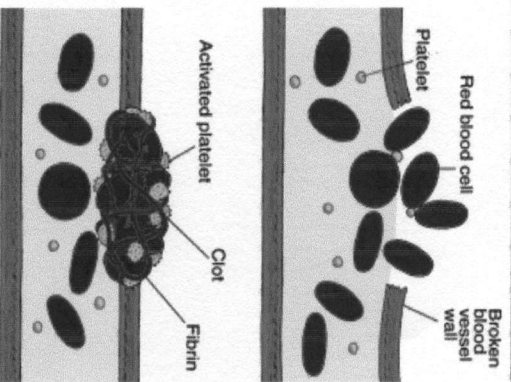

### Coagulation





# Overview of Haemostasis

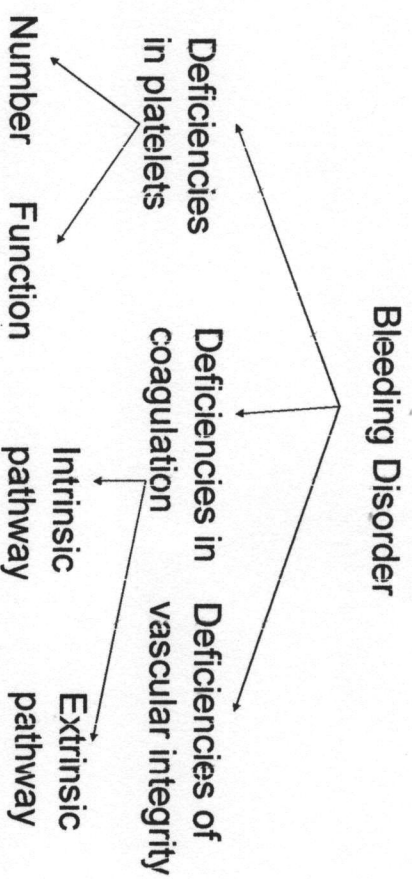
Blood vessel injured  
 ↓  
 Platelet plug (primary haemostasis)  
 ↓  
 Platelet plug stabilized by the fibrin mesh (secondary haemostasis)  
 ↓  
 Clot dissolution (fibrinolysis)



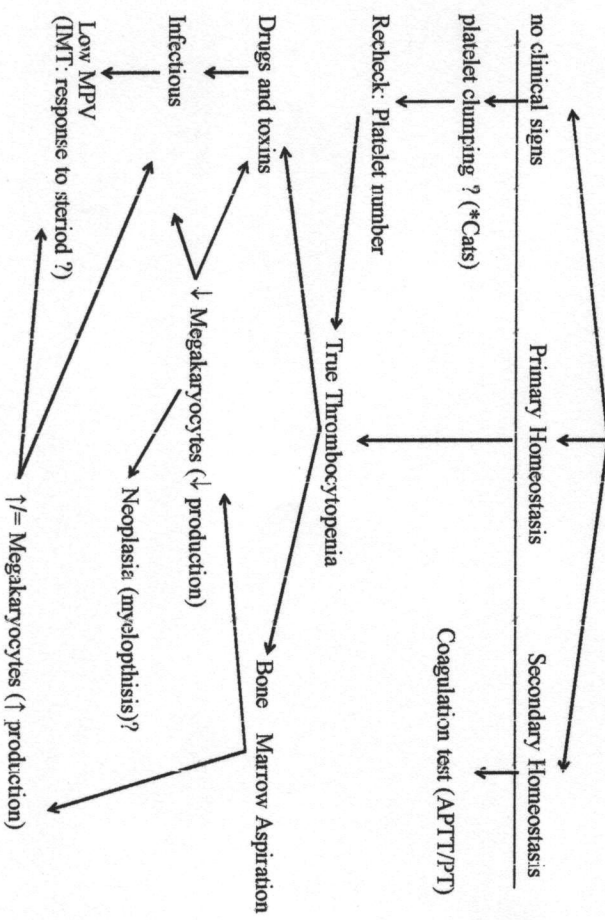
# Commonest causes of thrombocytopenia

- Dogs
  - *E. canis*
  - IMT
  - heartworm
  - lymphoma
  - haemangiosarcoma
  - Rocky Mountain spotted fever
  - leptospirosis
- Cats
  - FELV, FIV, FIP
  - *H. felis*
  - *Toxoplasma gondii*
  - lymphoproliferative
  - myeloproliferative
  - thromboembolism

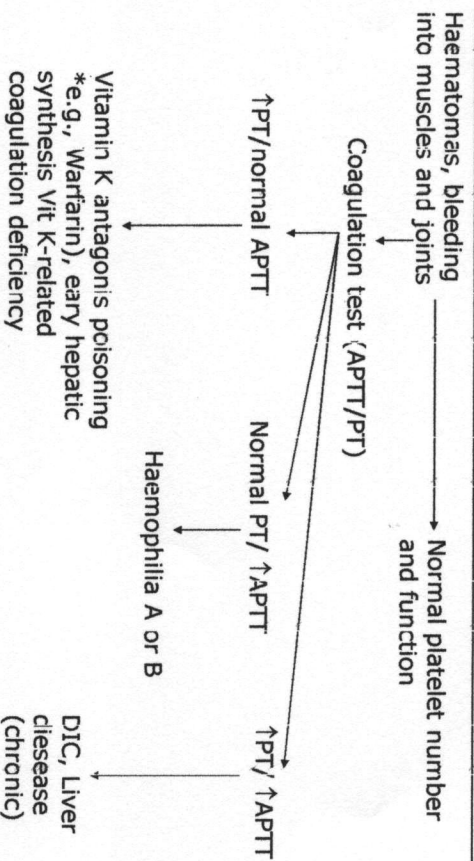
# Bleeding Disorder



## Thrombocytopenia



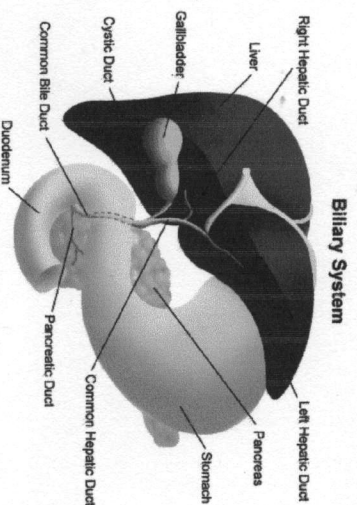
## Diagnosis plan for coagulopathy



## Liver Profiles

- Alanine Aminotransferase (Transaminase) (ALT)
- Aspartate Aminotransferase (Transaminase) (AST)
- Alkaline Phosphatase (ALP)
- Gamma-Glutamyl Transpeptidase (GGT)

## Liver Profiles



## Alanine Aminotransferase (Transaminase) (ALT)

- Cytosolic enzyme
- Advantage: Specificity for liver
  - ↑ Peak serum → ↑ number of hepatocytes affected but not indication the severity of the disease or its reversibility
- Disadvantage: Lack of sensitivity and inability to distinguish among primary and secondary hepatic diseases.



## Aspartate Aminotransferase (Transaminase) (AST)

- Advantage: Good indicator of degree of hepatic necrosis as well as a good screening test with a sensitivity of 88%.
- Disadvantage: found in many organs (muscle, heart and liver) → not a specific indicator of hepatic damage
- ↑ AST, (normal) ALT measurement → check of serum Creatine kinase (rule out muscle damage)
- not appear to have an advantage over ALT → not routinely used

## Gamma-Glutamyl Transpeptidase (GGT)

- less influenced by hepatocyte necrosis and more by biliary epithelium disease.
- specific of GGT > serum ALP
- sensitivity of GGT < ALP (Center, 1992).
- Bone lesions are not recognized to increase GGT.
- GGT has slight greater sensitivity in cats than in dogs (except hepatic lipidosis).

## Alkaline Phosphatase (ALP)

- Biliary disease
- Primary hepatic disease
- Hyperthyroidism, iatrogenic drug therapy (glucocorticoids, phenobarbital, or other)
- Bone lesion and osteoblastic activity from a bone source in young growing dogs.
- In cats, serum ALP activities are more specific for hepatobiliary disease.

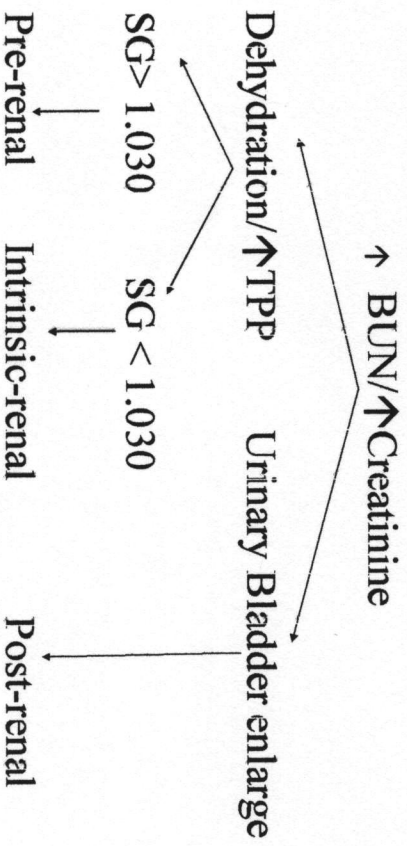
## Hepatic Enzyme

Enzyme	Origin	Advantage	Disadvantage
ALT	Hepatocyte	Liver specific	Lack of sensitivity
AST	Hepatocyte	Sensitivity 88%	Not a specific indicator
ALP	Biliary disease	Good Sensitivity	Osteoblastic activity Steroid induce
GGT	Biliary disease > Hepatocyte necrosis	specific > serum ALP Bone lesions do not affect	sensitivity < ALP

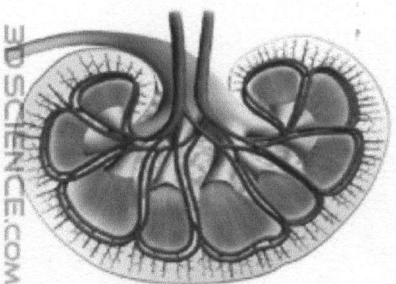
↑↑AST, ↑↑ALT, ↑↑ALP	Strongly evidence of serious hepatobiliary disease
↑=AST, ↑↑ALT, ↑↑ALP	Strongly evidence of hepatobiliary disease
↑↑AST, ↑↑ALT, =ALP	Strongly evidence of hepatic disease
↑↑AST, ↑=ALT, ↑=ALP	- GI disease, Muscle damage (↑CK), Rbc lysis - Hepatic disease? (recheck in 2-4 weeks)
↑=AST, ↑=ALT, ↑ALP	Dogs - Normal in young age (<6-10 months) - Adult → Bone disease? (e.g., osteomyelitis) Cats - Hepatic disease (e.g., lipidosis, cholangitis, Herperthyroidism, and DM) - Hepatobiliary disease - Herperadrenocorticism (check cortisol level)
↑=AST, ↑=ALT, ↑↑ALP	- Hepatobiliary disease - Herperadrenocorticism (check cortisol level)

= (normal) / ↑ (increase ≤ 3 times) / ↑↑ (increase ≥ 3 times)

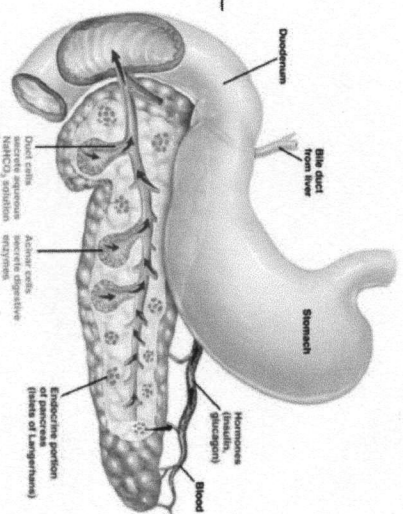
## Azothemia



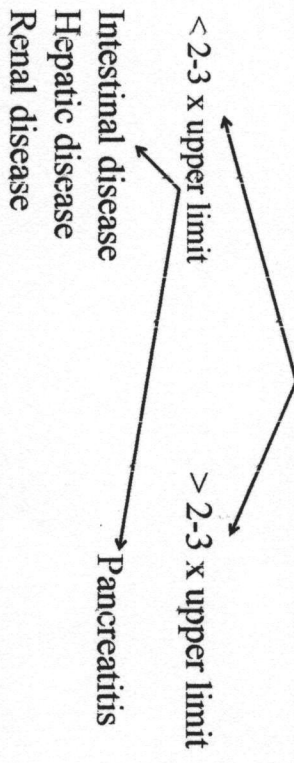
## Renal Function



## Pancreatic




Amylase/Lipase



□ Chronic Pancreatitis might have normal Amylase and Lipase level


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Thank you!


Trypsin-like immunoreactivity (TLI)

