# BASICS OF ELECTROCARDIOGRAMS

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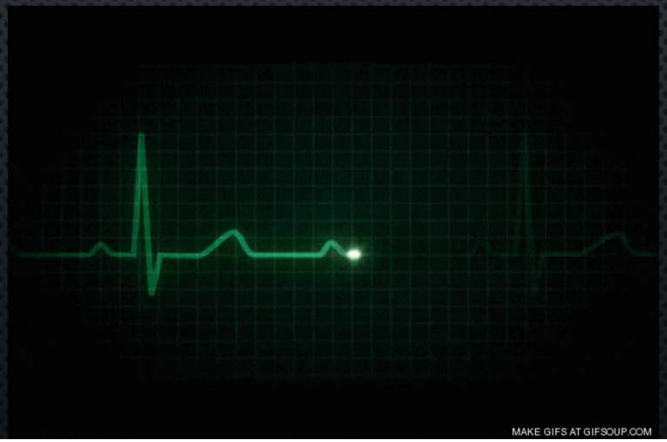



- Recommendations for monitoring circulatory system under GA
- Cardiac conduction system
  - Electrical pathway of the heart
  - Cardiac axis

# Electrocardiography (ECG) Application

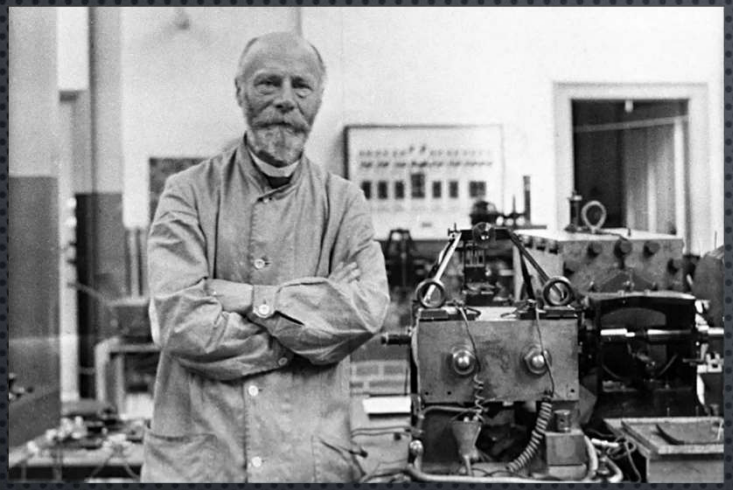
- Lead II placement
- Deciphering the ECG strip
- 8 questions to ask when interpreting an ECG strip
- Identification of EKG arrhythmias
  - causes
  - Treatments
- Arrest rhythms
  - Recover guidelines



- A 'PRESENT' ANESTHETIST
- HEART RATE, RHYTHM AND QUALITY
- ASSESSMENT OF PERIPHERAL PERFUSION
  - PALPATION FOR PULSE QUALITY
  - MUCOUS MEMBRANE COLOR
  - CAPILLARY REFILL TIME

- MONITORING EQUIPMENT:
  - PULSE OXIMETRY
  - ELECTROCARDIOGRAM
  - BLOOD PRESSURE
    - NON-INVASIVE (INDIRECT)
    - INVASIVE (DIRECT)

# HISTORY OF ELECTROCARDIOGRAPHY



## THEN

- INVENTED IN 1903 BY WILLEM EINTHOVEN
- NOBEL PRIZE IN 1924
- **"EINTHOVEN'S TRIANGLE"**

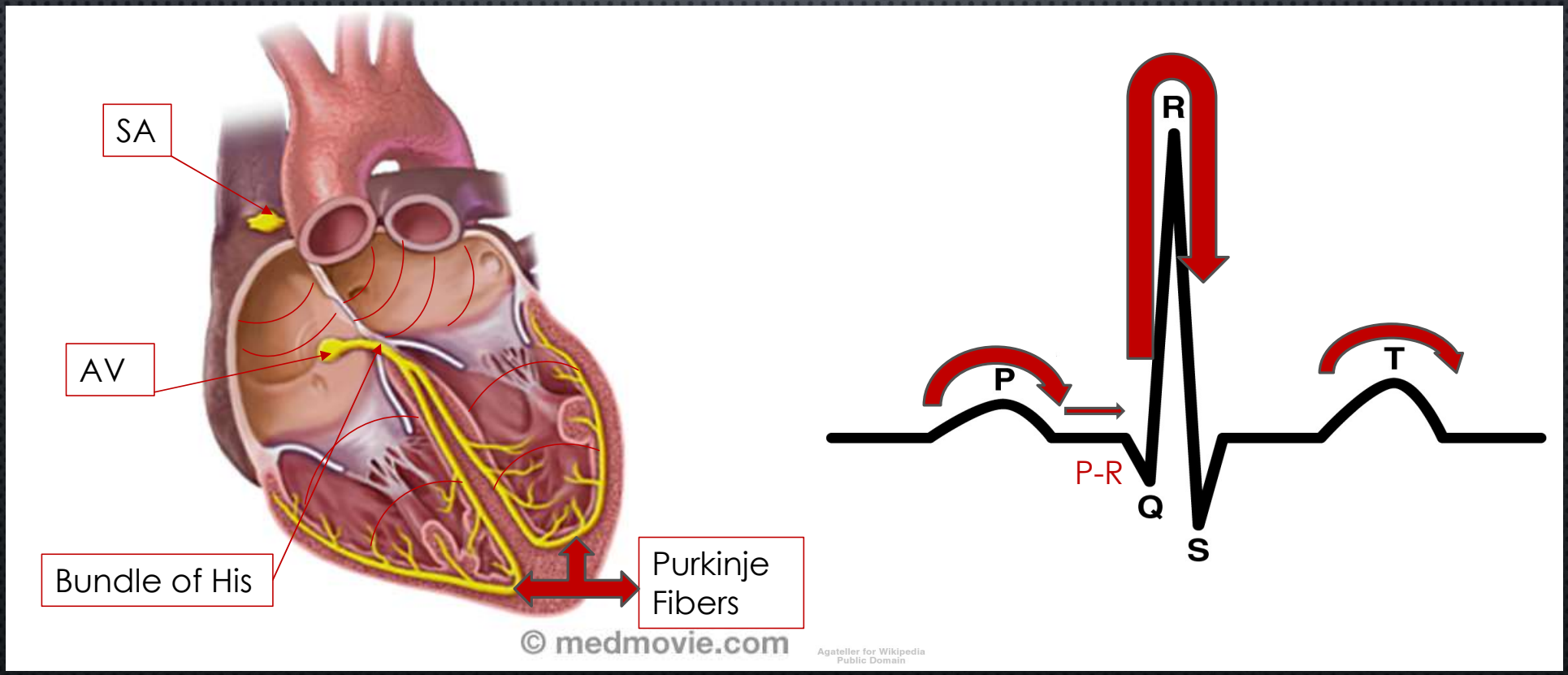

## NOW

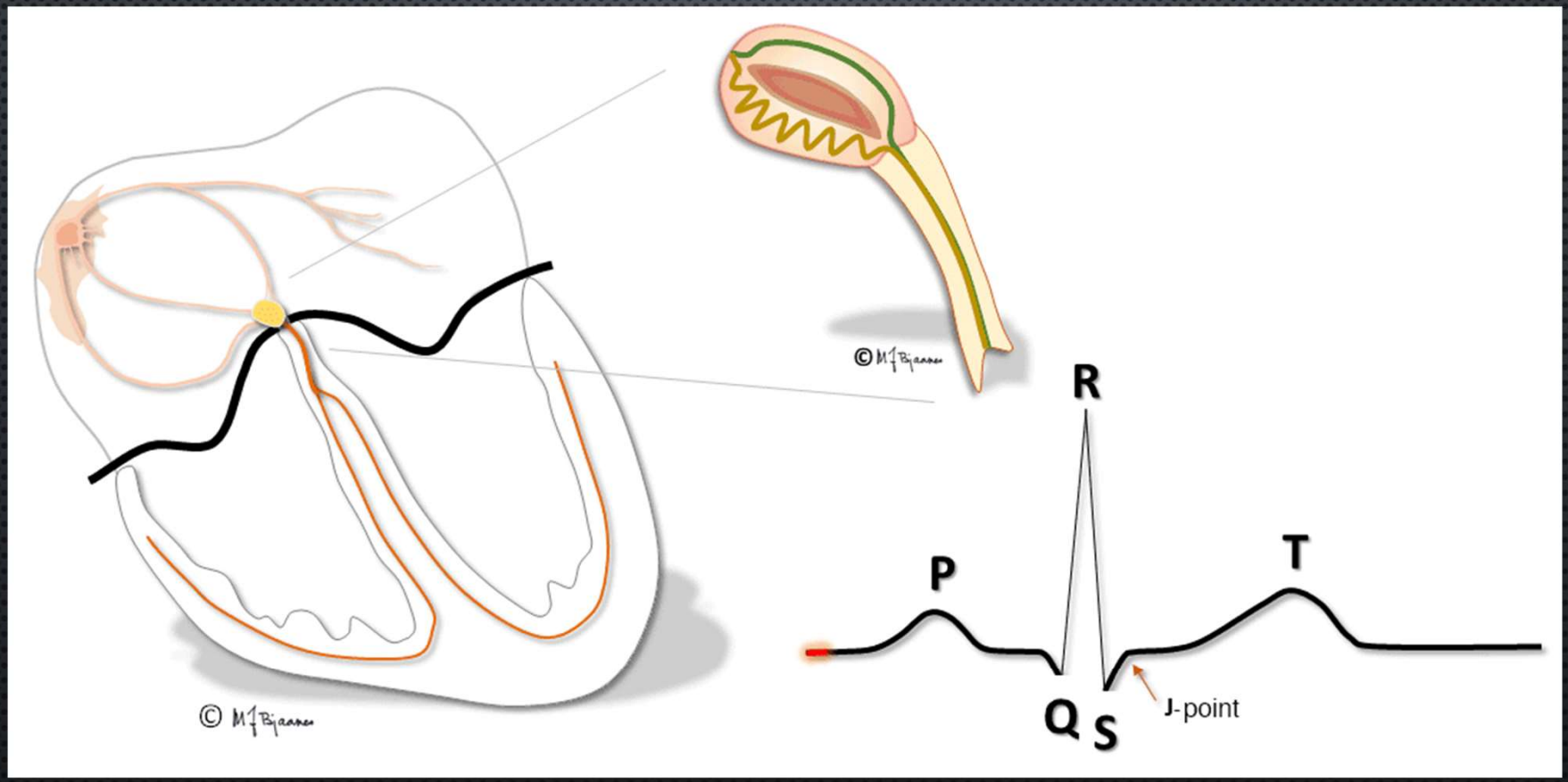
- COMPACT ELECTRONIC DEVICES
- COMPUTERIZED INTERPRETATION OF ELECTROCARDIOGRAMS
- STANDARD OF CARE IN HUMAN AND VETERINARY MEDICINE

# Electrocardiograms (ECG/EKG)

- Measures the electrical activity of the heart muscle, creating a waveform.
  - **Does not indicate mechanical function.**
- Requires interpretation
- Communicates:
  - Heart rate
  - rhythm

# CARDIAC CONDUCTION SYSTEM




R
P
T
Q
S
J-point

## Einthoven's Triangle

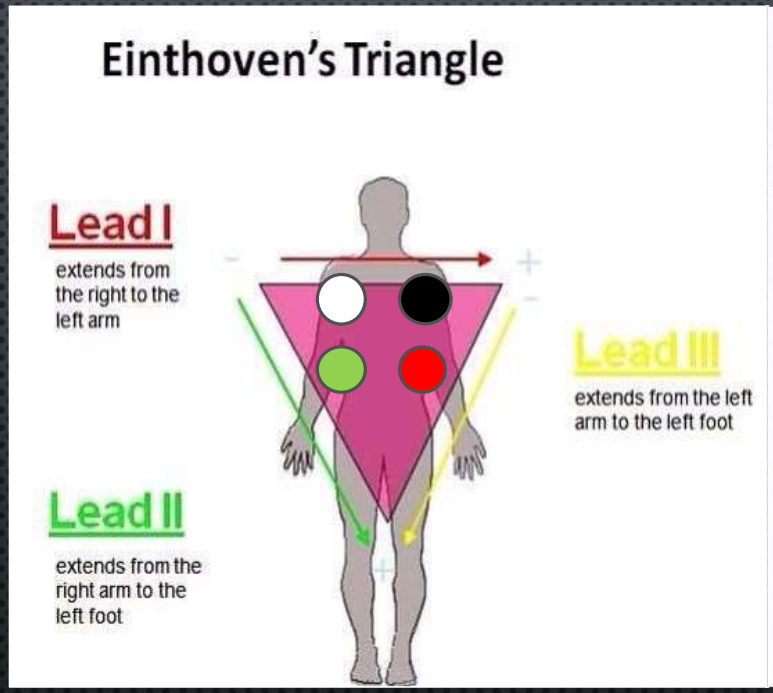
- LEAD I: RA (-), LA (+)
- LEAD II: RA (-), LL (+)
- LEAD III: LA (-), LL (+)

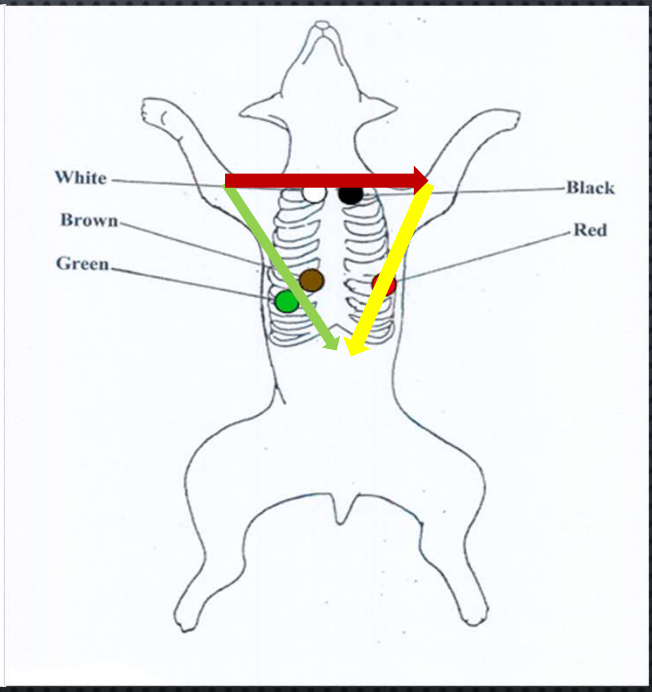
Right Side:

- **WHITE** on the **RIGHT**
- **SNOW over GRASS**

**Left Side:**

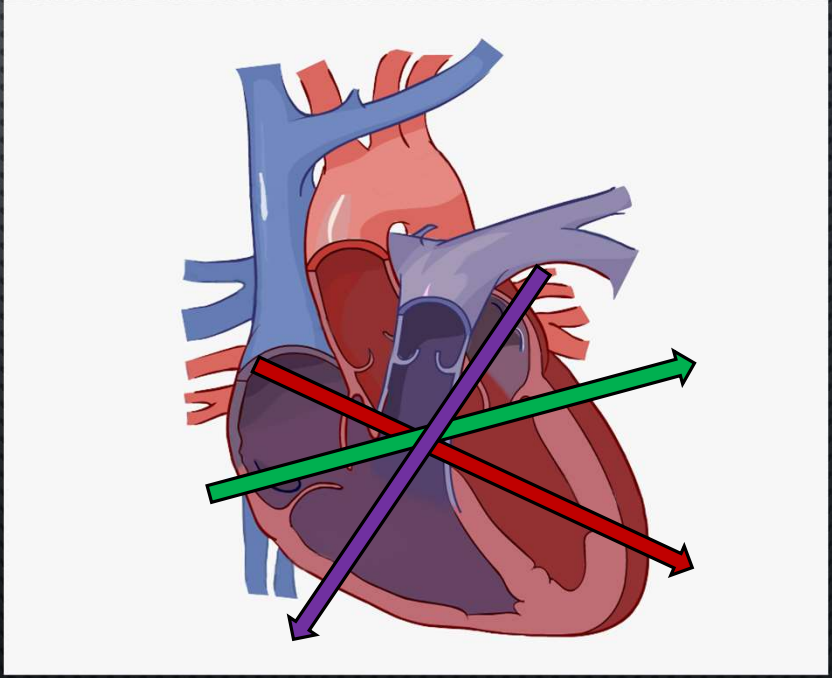
- **SMOKE over FIRE**



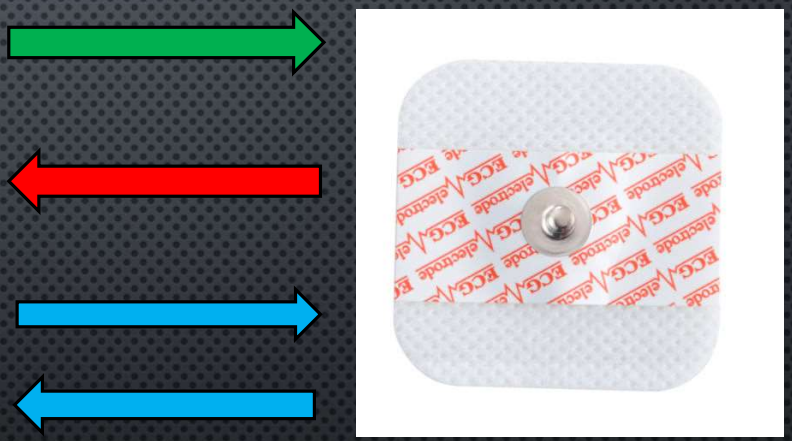



# CARDIAC AXIS INTERPRETATION

- The net direction of electrical activity during depolarization.
  - In a healthy heart:
    - Movement is **DOWNWARD** and slightly to the **LEFT**.
- Examples of some common deviations:
  - **LEFT** ventricular hypertrophy
    - Axis is skewed further **LEFT**.
  - **RIGHT** ventricular hypertrophy
    - Deviation to the **RIGHT**.



- Depolarization **TOWARD** a lead will produce a **POSITIVE** deflection.
- Depolarization **AWAY** from a lead gives a **NEGATIVE** deflection.
- **Equiphasic** complex have roughly similar amounts of positive and negative deflections.

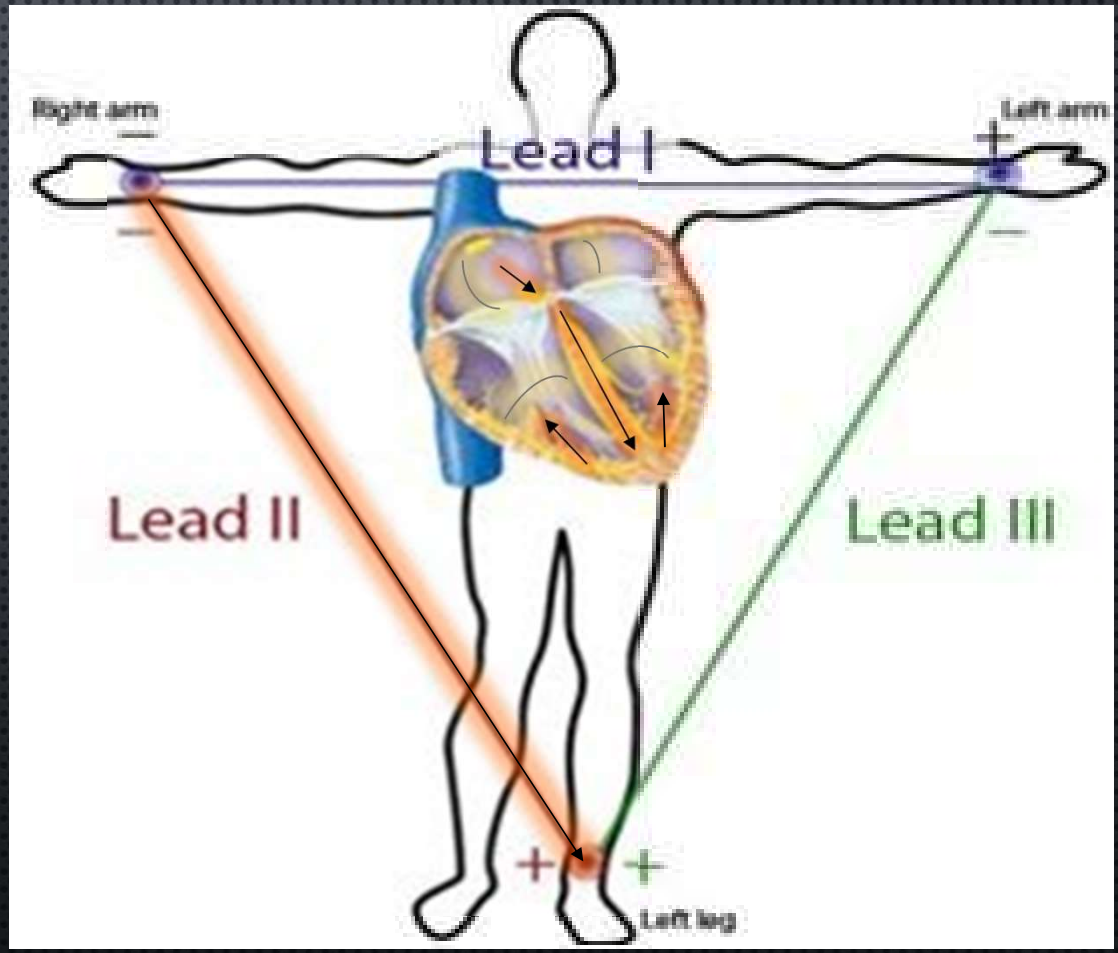


## *WHAT IS A **LEAD?***

- Difference in energy between two points creating a waveform.
  - Not to be confused with an electrical lead **cable**.

- WHY IS **LEAD II** THE PRIMARY LEAD USED UNDER GA?

Closest to the cardiac conduction system pathway.



# ARTIFACTS

1. 60 cycle interference
   - Caused by an electrical interference.
     - Nearby electrical appliance.
2. Muscle tremors/movement
   - Due to skeletal tremors.
     - Irregular oscillations of the baseline.
       - Causes:
         - i.e. hypothermia, pain
3. Respiratory movement
   - Placement of electrodes on the bottom of patient's paws.

# Questions to ask when reading an EKG

1. What is the heart rate (HR)?
2. Is there a P for every QRS complex?
3. Is there a QRS for every P wave?
4. What is the rhythm? (Irregular or regular)
5. Is the PR interval consistent?
6. What is the QRS morphology?
7. Are the "T's" tall/tented?

# DECIPHERING THE ECG : CALCULATING HEART RATE

**RULE:**

- 50mm/s: 10 big box=1s
- 25mm/s: 5 big box=1s

**Pen Technique:**

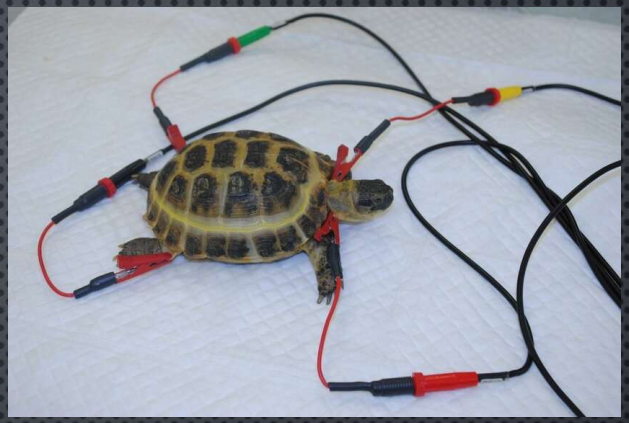
- 25mm/s:pen=6s
- # of complexes x 10=~HR



**7 complexes x 10=~70bpm HR**

# BRADYARRHYTHMIAS

- Characterized by a regular or irregular heart rate rhythm that is considered slower for that species.
- These include:
  - Sinus bradycardia
  - Atrioventricular block
    - 1st degree
    - 2nd degree
      - Mobitz type I (benign)
      - Mobitz type II (+/- concerning)
  - Escape beat rhythm



**Factors that contribute to bradycardia:**

- Cardiovascular disease
- High vagal tone
- Drug reduced secondary to Alpha-2 agonist administration
- Cushing's Reflex

# VARIABLE RANGE WITH HEART RATES AMONG CATS AND DOGS.

- Cats:
  - ~160-200bpm
- Dogs:
  - ~60-140bpm
- Age, breed, size, Fear, anxiety, and stress (FAS)
- Important to obtain a 'resting' heart rate before general anesthesia!
- How much does heart rate and cardiac output drop under anesthesia?

# SINUS BRADYCARDIA

- COMMON UNDER GENERAL ANESTHESIA
- AGE, SPECIES, BREED VARIABILITY

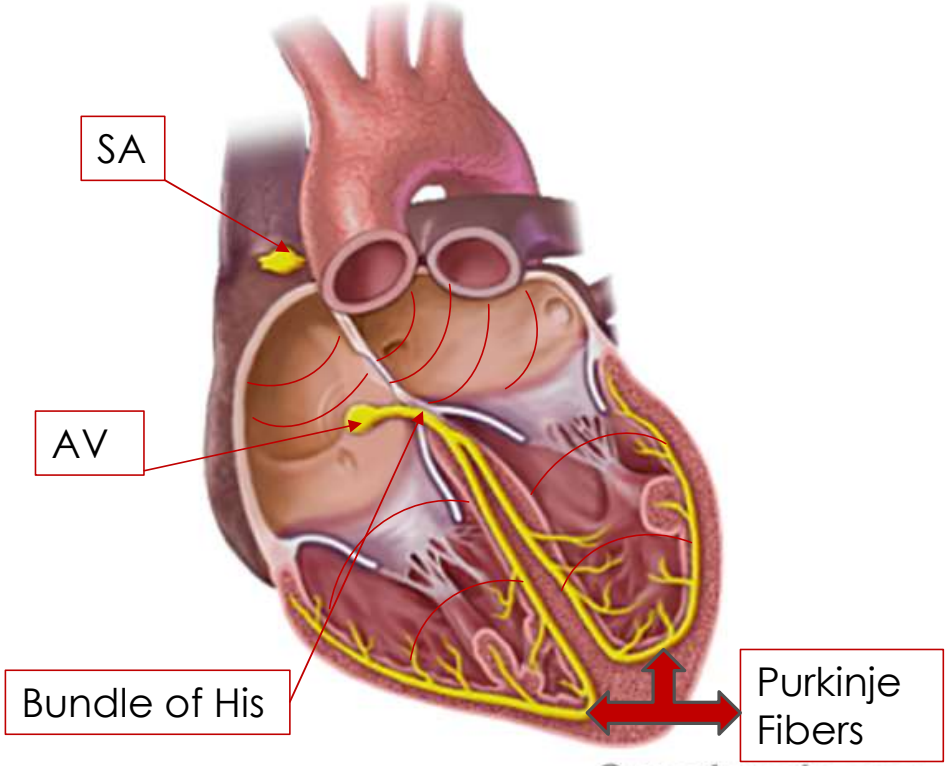
- **CAUSES:**
  - DRUG INDUCED:
    - OPIOIDS
    - ALPHA-2 AGONISTS
    - EXCESSIVE ANESTHETIC DEPTH
    - HYPOTHERMIA

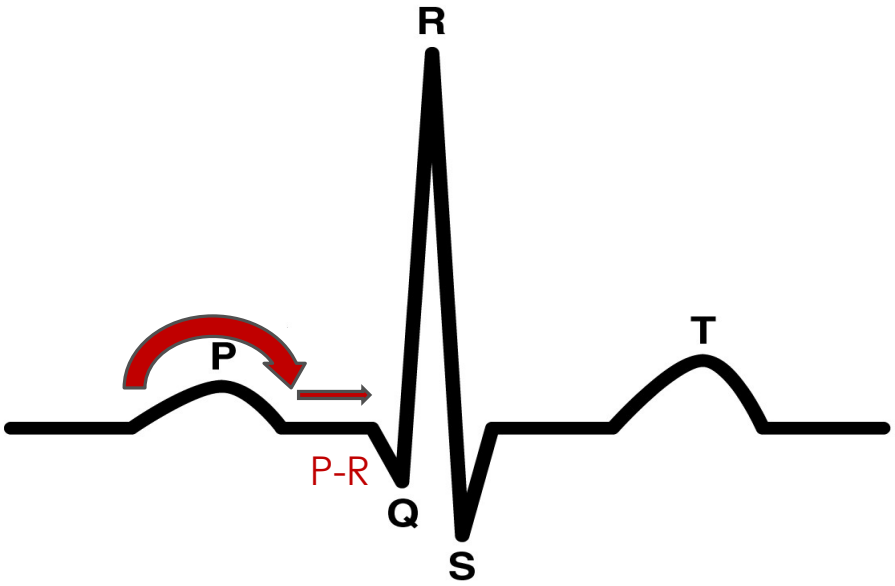
- **To Treat or Not to Treat?**
  - Is there a risk to the patient's safety?
    - **Hypotension**
  - Anticholinergics
    - Atropine
    - Glycopyrrolate
  - **Is the anesthetic depth too deep?**
    - Lighten plane of anesthesia

- **Reversal drugs?**
  - Naloxone
  - Atipamazole

*uncommonly indicated under GA, sometimes post-operatively (e.g., prolonged recovery)

# CARDIAC CONDUCTION SYSTEM



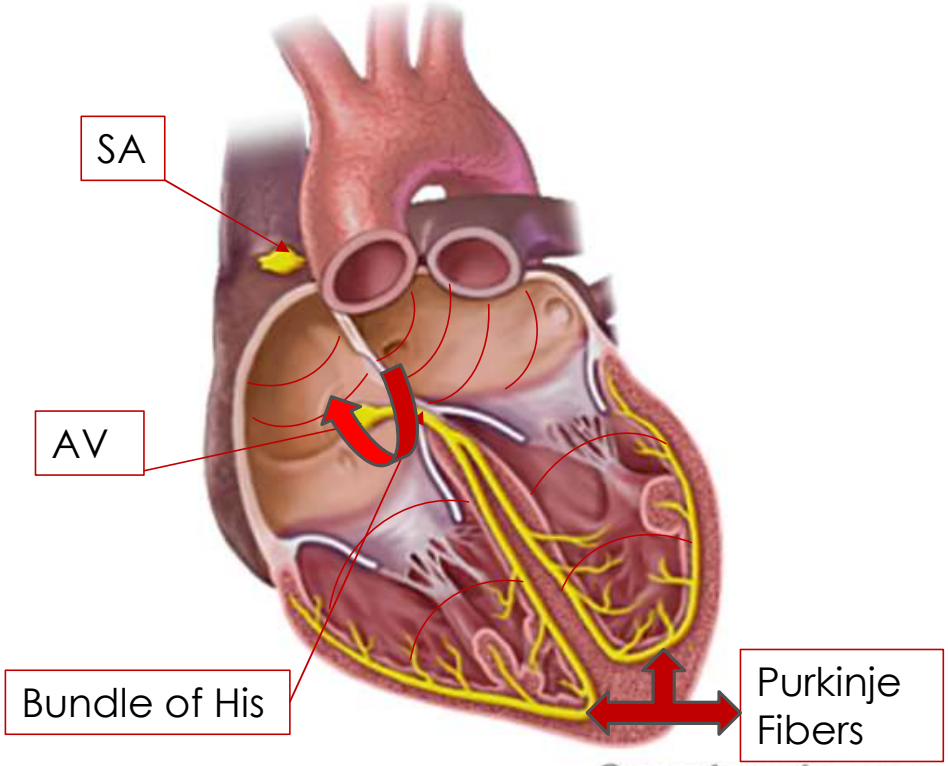



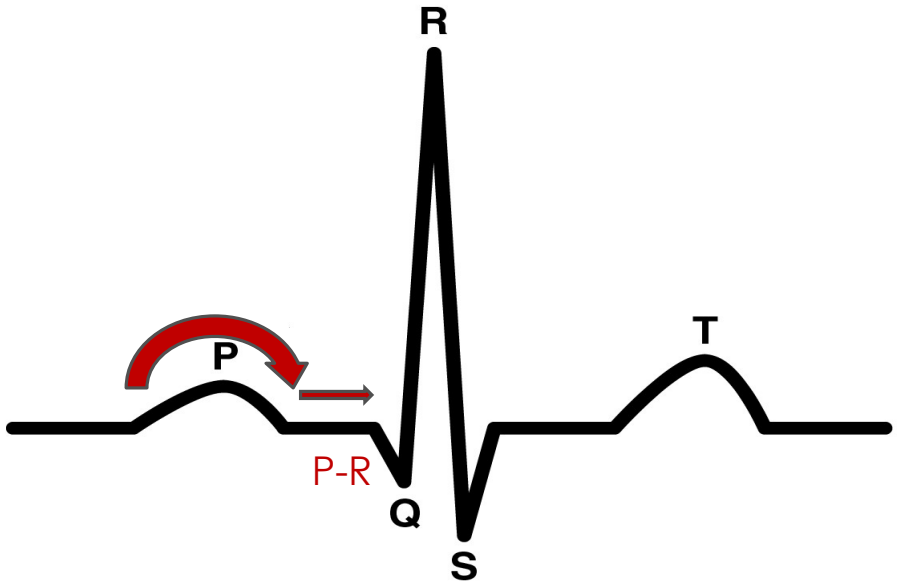
# 1ST DEGREE AV BLOCK


- **CHARACTERIZED BY:**
  - PROLONGED P-R INTERVAL
    - DELAY IN CONDUCTION OF THE AV NODE.
  - USUALLY BRADYCARDIC

- **Causes:**
  - Increased vagal tone
  - Opioids
  - Alpha-2 agonists (e.g., Dexmed)

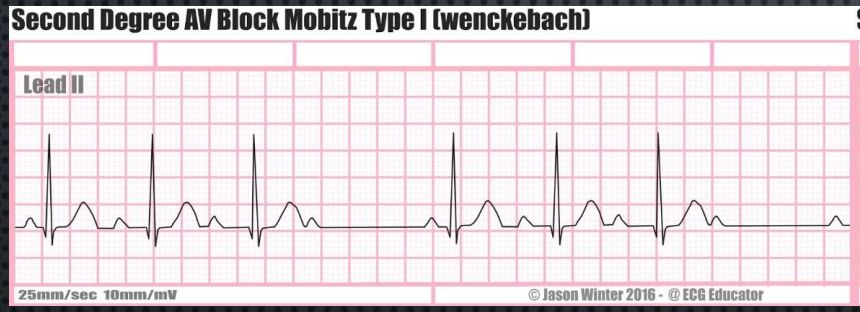
# CARDIAC CONDUCTION SYSTEM

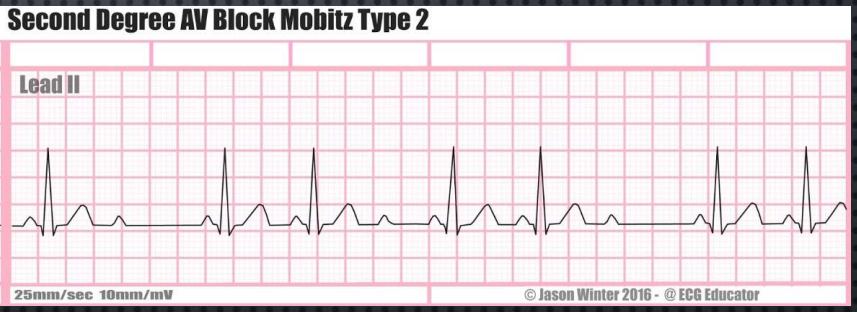


# 2ND DEGREE AV BLOCK

- **MOBITZ TYPE I (BENIGN)**
- **MOBITZ TYPE II (CONCERNING)**

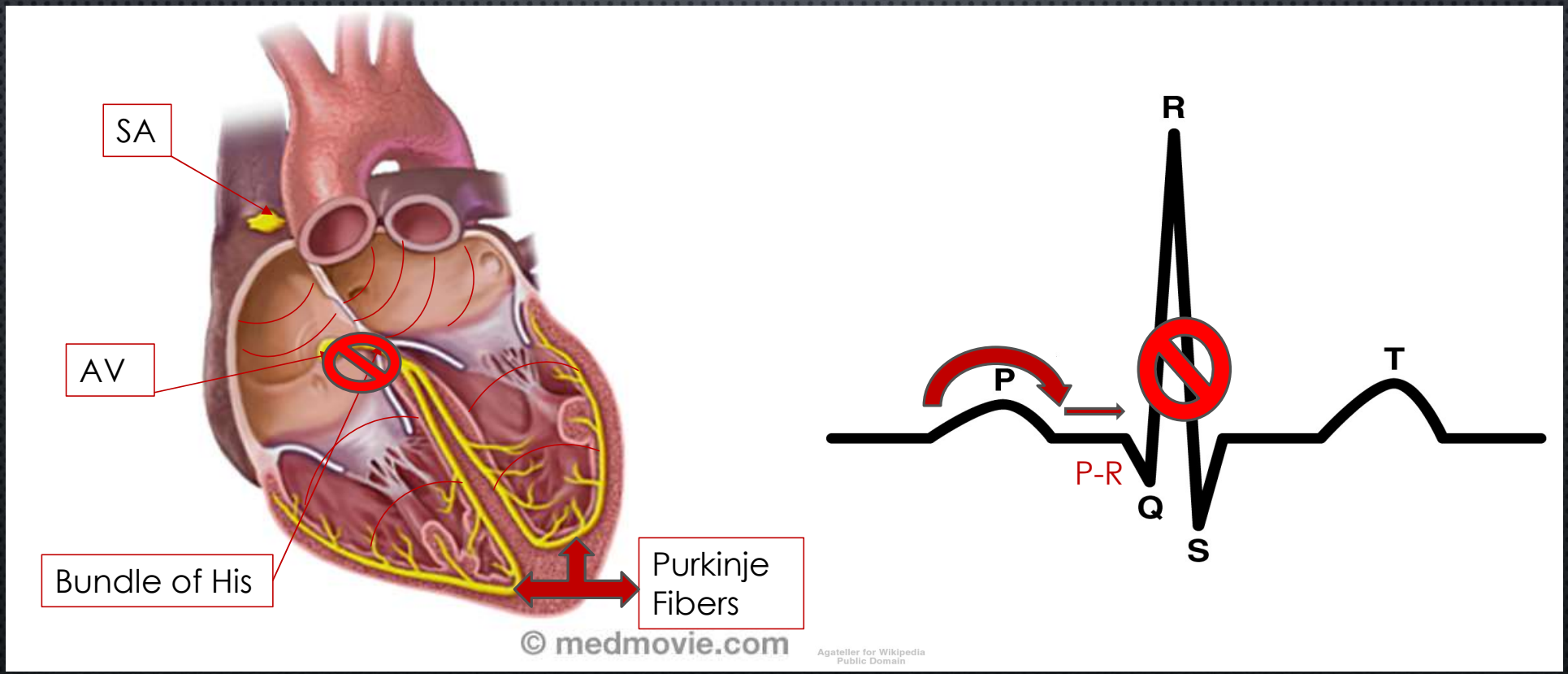



- Slow
  - Type 1:
    - Longer P-R interval due to AV node cell fatigue
  - Type 2:
    - P-R interval constant with intermittent dropped beat.
- Often irregular HR
- Absent QRS following some P waves

- Causes:
  - High vagal tone
  - Opioids
  - Alpha-2 agonists
  - Electrolyte derangements
  - Hypothermia

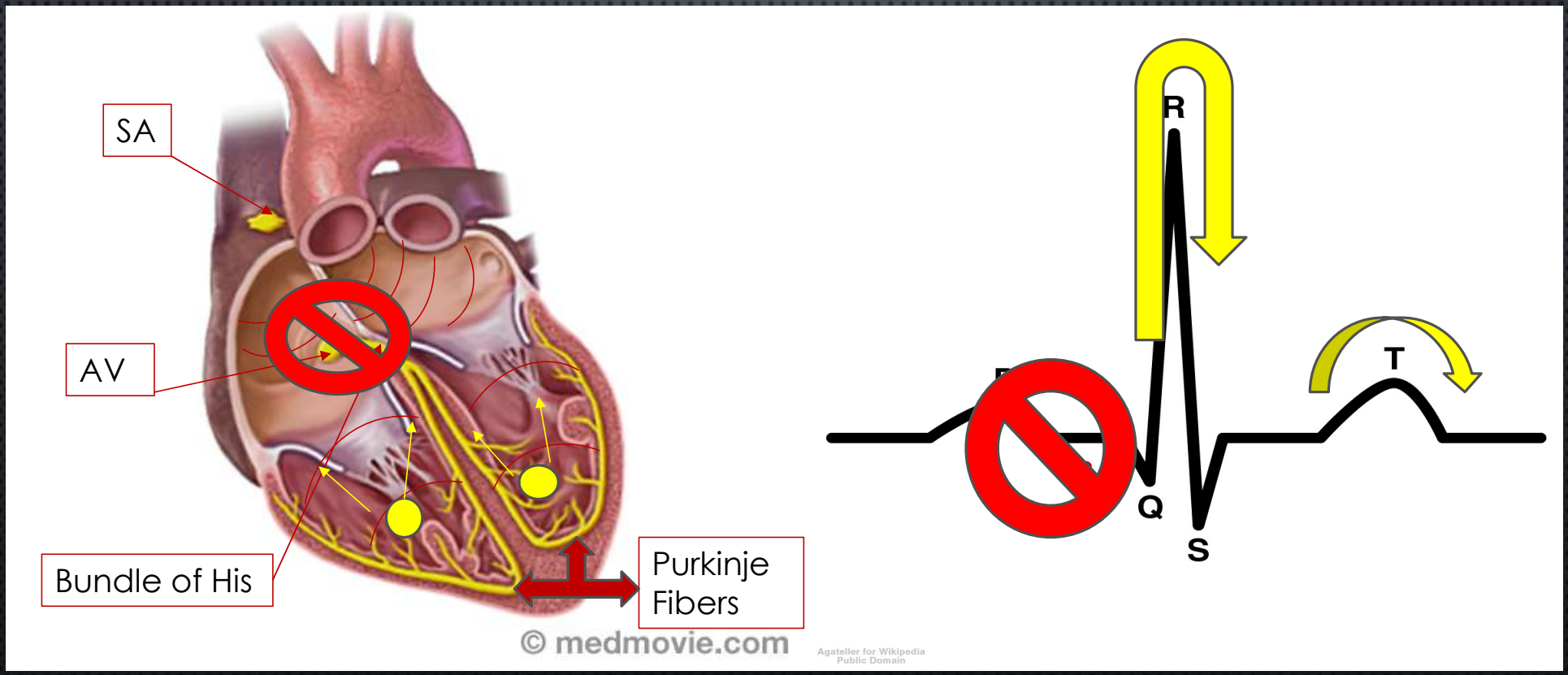
# CARDIAC CONDUCTION SYSTEM



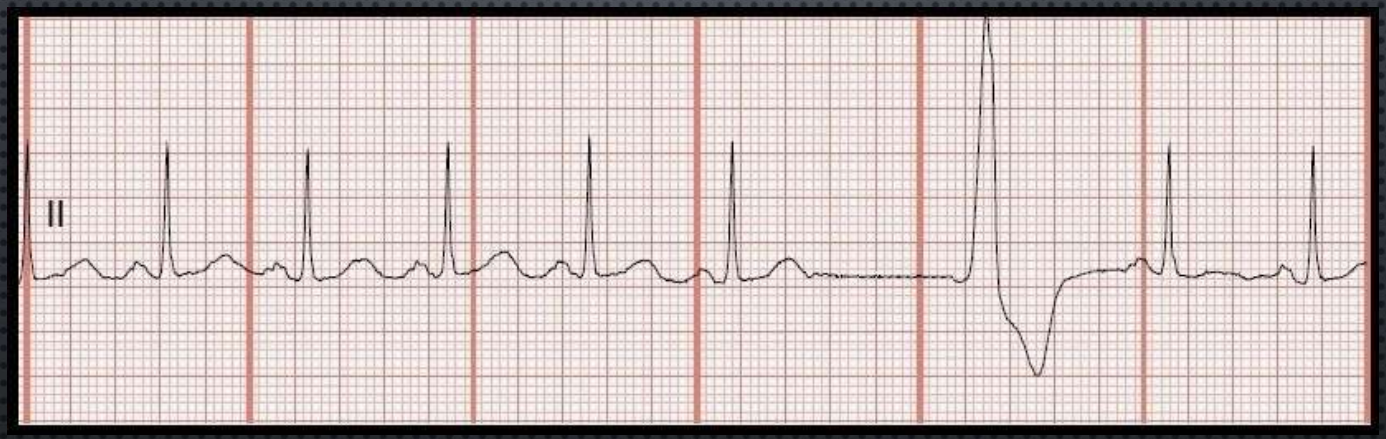
# 3RD DEGREE AV BLOCK


- **Characterized by:**
  - Complete dissociation between SA & AV node.
  - Dogs: ~30-60bpm
  - Cats: ~80-130bpm
- **Causes:**
  - Often unknown
- **Treatment:**
  - Atropine challenge
  - Refer for cardiac workup and/or pacemaker.

# CARDIAC CONDUCTION SYSTEM

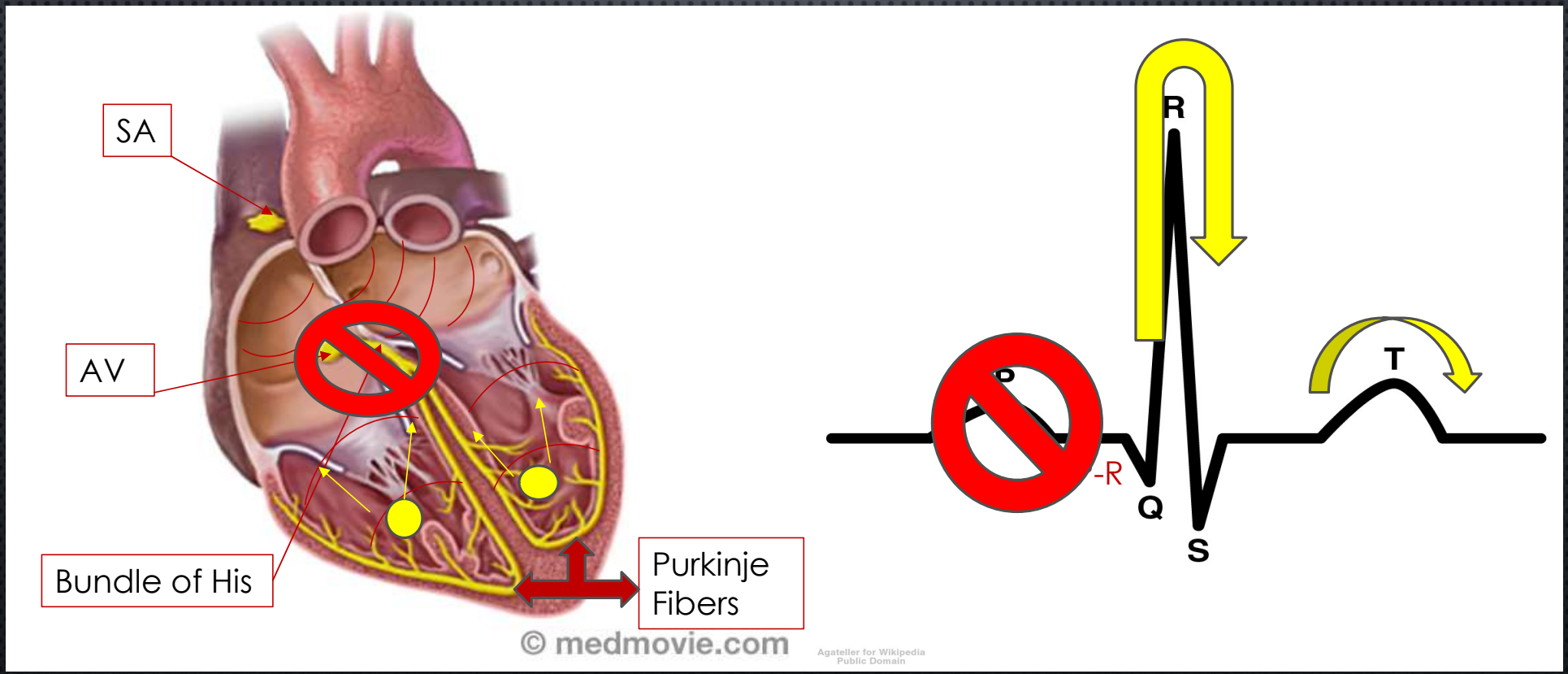


# VENTRICULAR ESCAPE BEATS

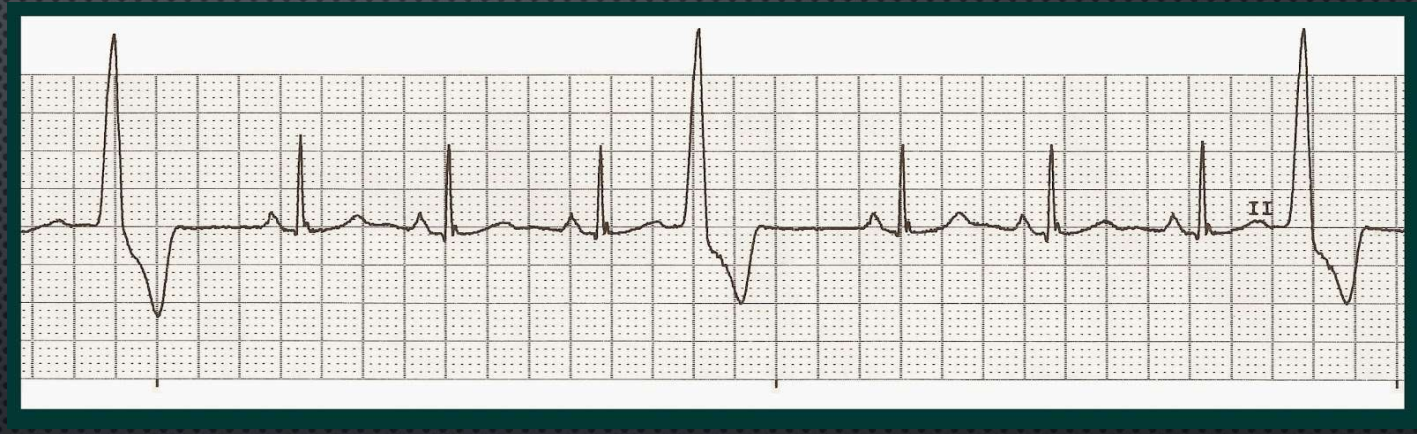



- **Characterized by:**
  - Slow HR:
    - Cats: ~90-100bpm
    - Dogs: ~40-60bpm
  - P waves not present for every QRS complex.
  - Irregular rhythm
    - Long pause following normal dominant rhythm with odd QRS complex.
- **Causes:**
  - High vagal tone
  - Cardiac disease
    - Conduction system
- No treatment needed, but they should be noted in record.

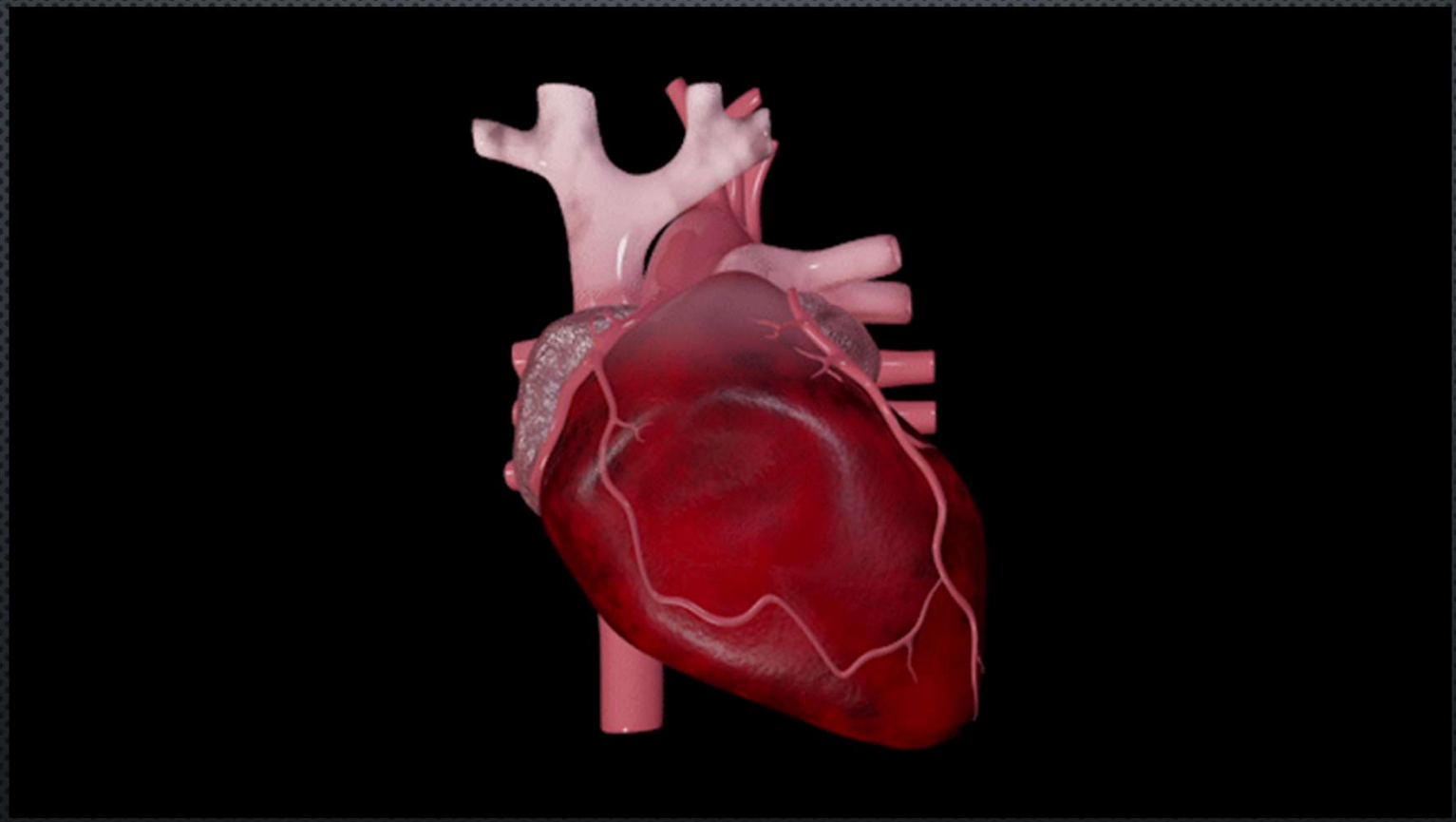
# CARDIAC CONDUCTION SYSTEM



# VENTRICULAR PREMATURE BEATS (PVC/VPC)




- **Characterized by:**
  - Early or premature appearance
    - Wider than normal QRS complex with a T wave
  - No P wave
  - Irregular rhythm
  - Pause following VPC
- **Causes:**
  - Increased sympathetic tone
    - Pain, stress, trauma
  - Acid-base abnormalities
  - Cardiac Disease
  - Surgical emergencies
  - Drugs
- **Treatments:**
  - Drug administration
    - Pain
    - Stress

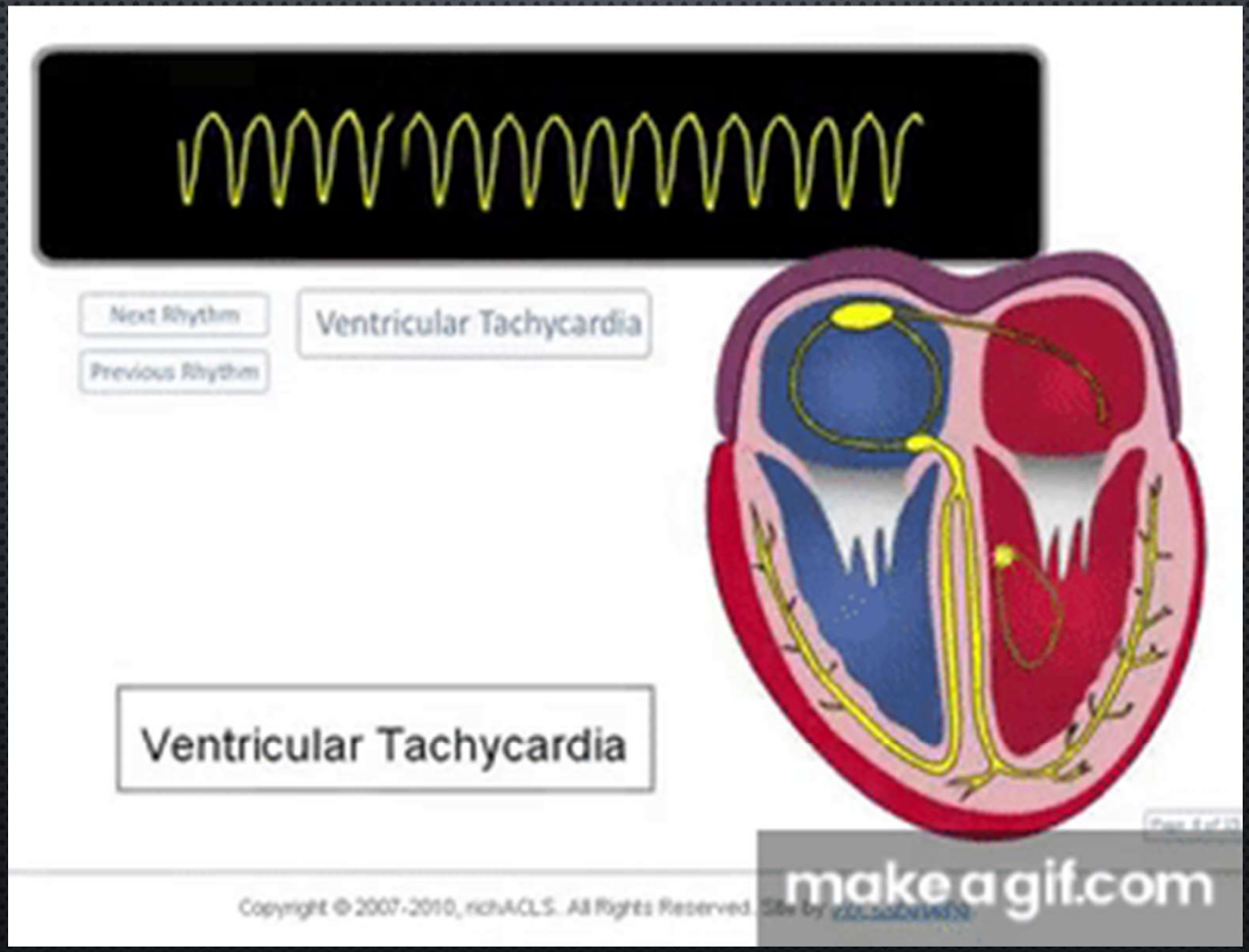


# SINUS TACHYCARDIA

- **Causes:**
  - Pain
  - Light anesthetic depth
  - Anticholinergic
  - Dissociative drugs
  - Hypotension
  - Hypoventilation

- **Negative side effects include:**
  - Increased myocardial oxygen consumption
  - Decreased cardiac output
    - Results in reduction in stroke volume
      - Leads to **hypotension** and **decreased perfusion**.


- **Treatment:**
  - Identify underlying cause
    - Drug administration:
      - Crystalloids, hypertonic saline, colloids, opioids, etc.


Next Rhythm
Previous Rhythm
Ventricular Tachycardia
Ventricular Tachycardia
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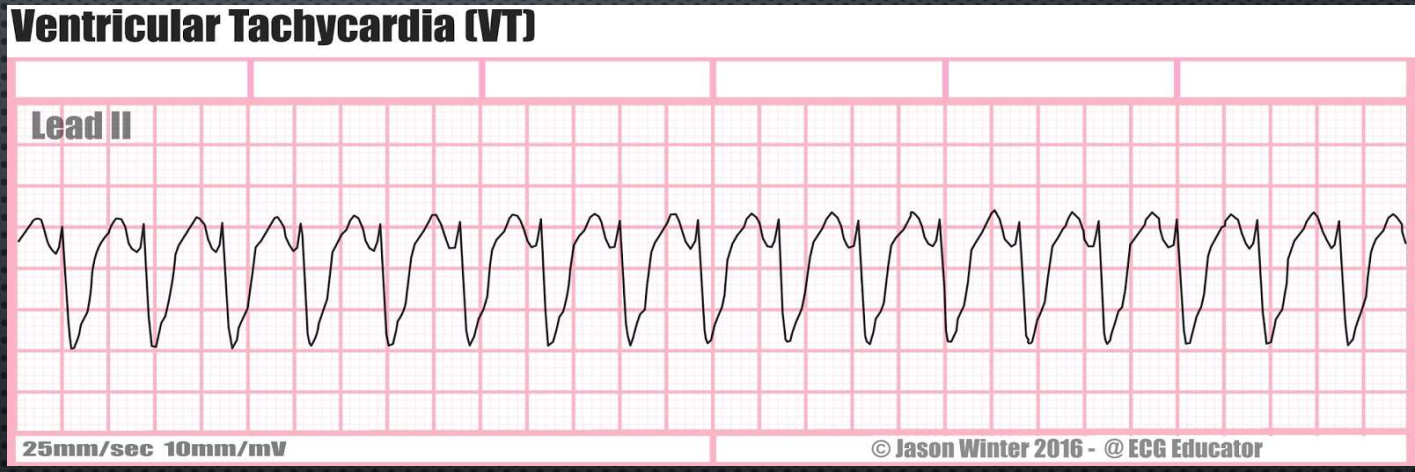
makeagif.com

# VENTRICULAR TACHYCARDIA (VTACH)

- **Characterized by:**
  - Ventricular rhythm HR of:
    - Cats: >220bpm
    - Dogs: >150-180bpm
  - Rapid, repetitive contractions
    - Due to abnormal electrical impulses in the ventricles.

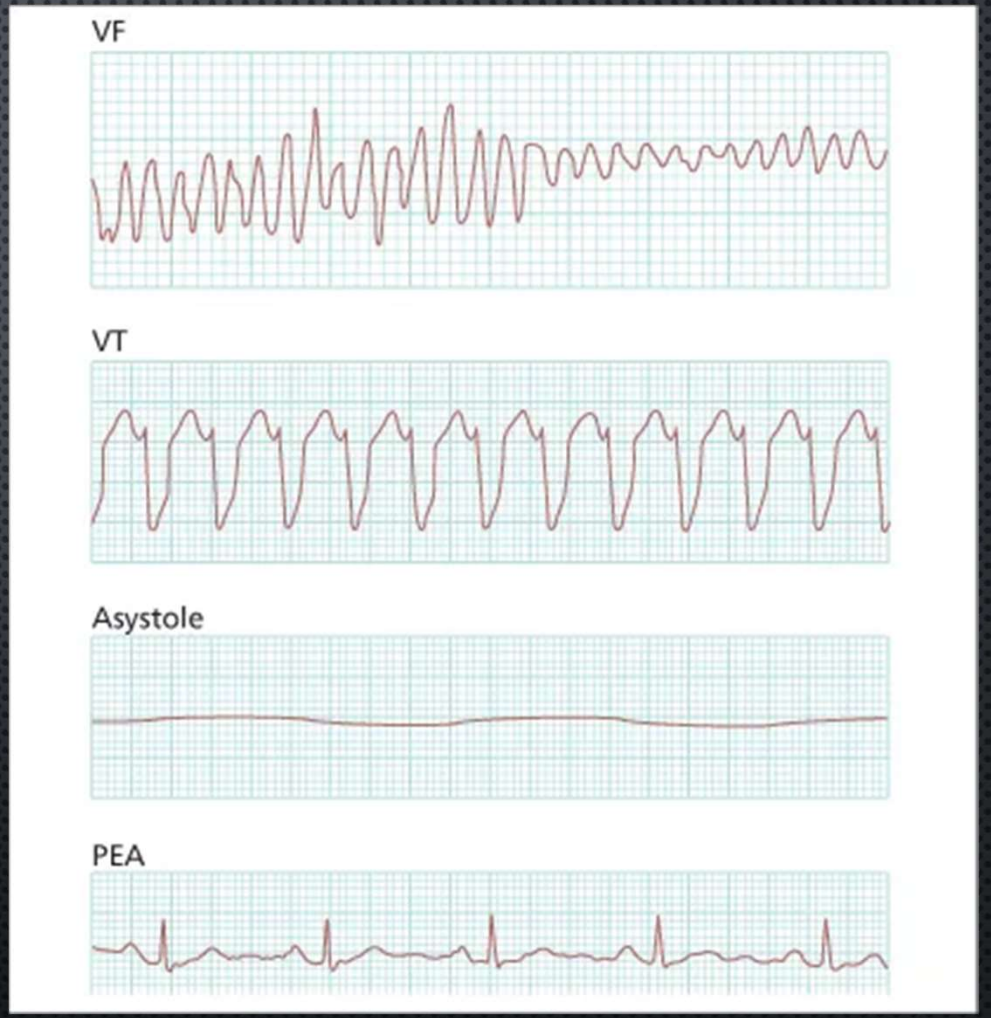



- **LIFE THREATENING ARRHYTHMIA!**
  - Pulseless Ventricular Tachycardia
  - Ventricular Fibrillation

- **Treatment:**
  - For sustained Vtach:
    - Lidocaine
    - Procainamide

# ARREST RHYTHMS

- **Nonshockable Rhythms:**
  - Asystole
  - PEA
- **Shockable Rhythms:**
  - Pulseless Vtach
  - Vfib
- **Treatment:**
  - Nonshockable Rhythms:
    - CPR
    - Epinephrine/vasopressin
  - Shockable Rhythms:
    - CPR
    - Defibrillation
    - Lidocaine/Amiodarone



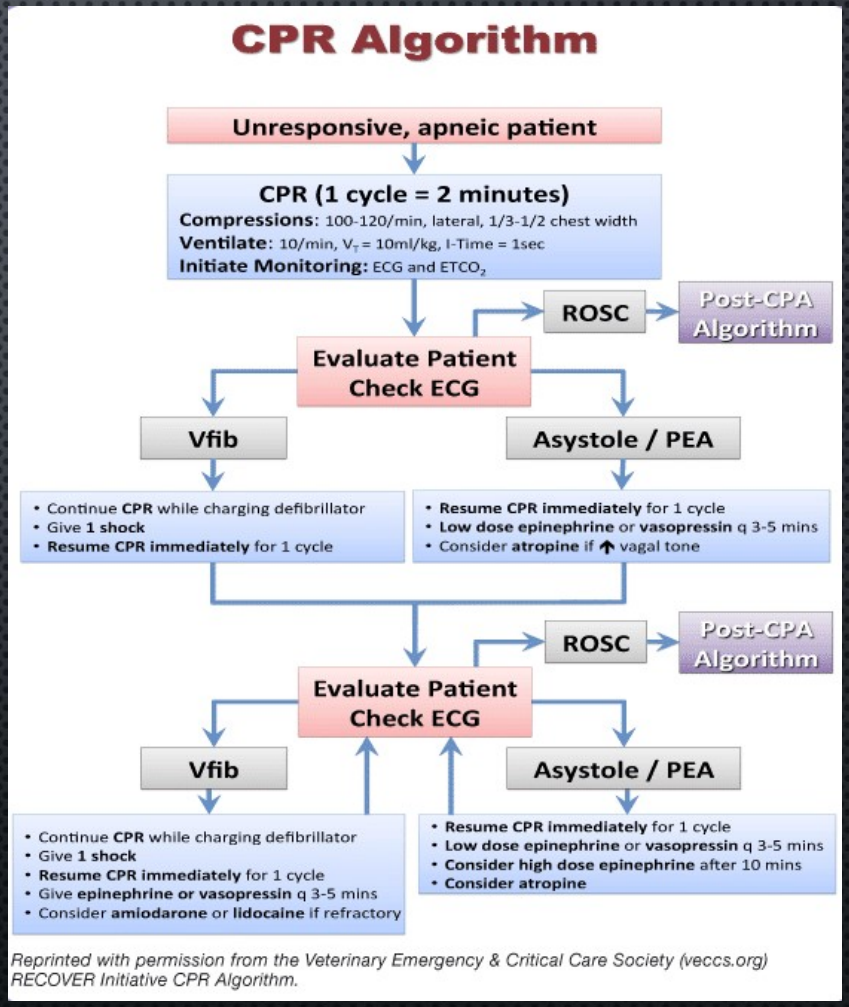

**Recoverinitiative.org**

# WHAT IS THE RECOVER INITIATIVE?

- Reassessment campaign on veterinary resuscitation (RECOVER)
  - 3 goals:
    - guidelines
    - Education
    - Research
- Non-profit, volunteer based program through ACVECC & VECCS.
  - dedicated to providing standardized guidelines, high-quality education, and evidence based research.


**RECOVER Certified BLS & ALS Instructor**

- Instructs and certifies veterinary professionals:
  - BLS and/or ALS Certified RESCUER




*Reprinted with permission from the Veterinary Emergency & Critical Care Society (veccs.org) RECOVER Initiative CPR Algorithm.*

- Cardiac axis can be determined by examining the **6 limb leads**.
- QRS axis is the most important!
  - Easiest to determine.
    - **QRS=Ventricular Depolarization!**
- "Normal" QRS axis:
  - -30 & +90
- Left axis deviation:
  - -30 & -90
- Right axis deviation:
  - +90 & +180
- Northwest axis or extreme deviation:
  - -/+180 & -90

Maybe…..

This is actually not the most useful for 'basic' understanding and application of ECGs….consider removing axis discussion.