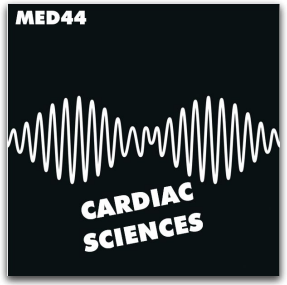
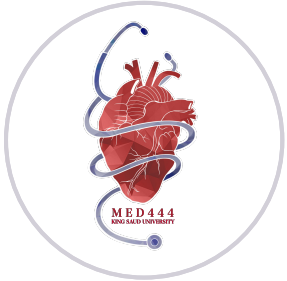
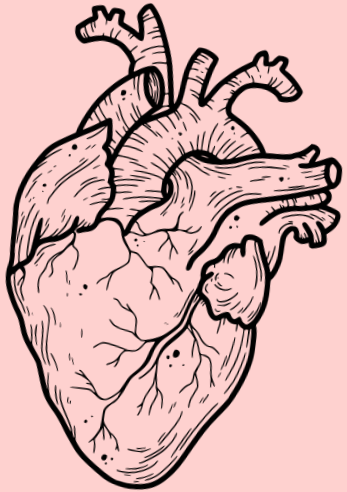


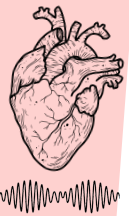




ARRYTHMIAS

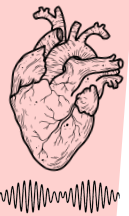
Editing File

Main text Female's slide Male's slide Important text Doctor's note Extra



Objectives

- Describe sinus arrhythmias
- Describe the main pathophysiological causes of cardiac arrhythmias
- Explain the mechanism of cardiac block
- Enumerate the common arrhythmias and describe the basic ECG changes



Read This Before you Continue

1. We recommend you study the Physiology ECG lecture before you study this lecture.

2. In terms of the exam, we don't know how the questions will come. It may come as a an ECG strip picture and you will be asked to identify the rhythm.

3. ECG is a very complex topic with many intricacies above a 1st year's level. However there are important basic topics that you should be able to identify, like Sinus rhythm, Atrial Fibrillation/Flutter and AV Blocks.

4. Everything in slides is included. However there are things we see as more **important** from our point of view and reviewing the objectives. so we wrote it in **red**. But **nothing is from the doctor**.

5. The Lecture is simple if you understand it. We highly recommend you check the summary and the stepwise approach alongside the video of our explanation it in the next 3 slides. It covers all content covered in this lecture in an organized manner (if you understand it, it will be ان شاء الله more than enough for your level.)

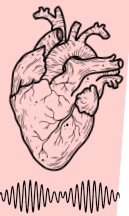
1

Video:
Explaining The lecture by the team leader

00:00 - 51:01

Our Approach and Summary

Don't be scared, the next 3 pages contain the basic approach to ECG for a medical student level + a summary of all ECGs mentioned in the lecture with clear pictures + how to identify them



Stepwise Approach to Reading ECG

Thanks to Dr. Jason Ryan (B&B) for the approach <3

Extra slide

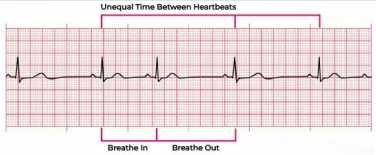
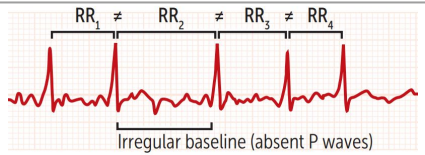
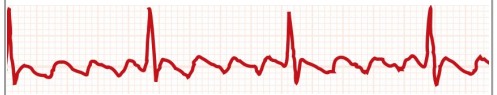
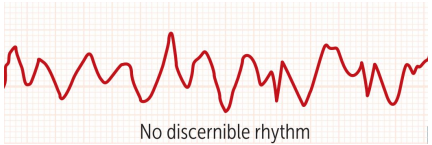
Video:
Intro + Approach
00:00 - 11:25

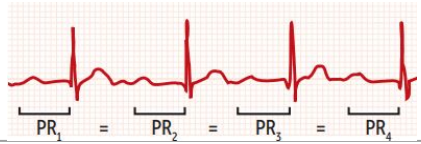
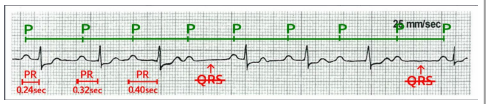
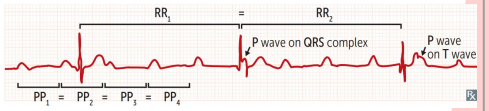
- **Step 1: are there p waves?**
  - *sinus p waves = originate in SA node = upright in lead II, III, AVF (inferior)*
- **Step 2: Regular/Irregular R-R Interval?**
  - P waves present + Regular→ *Most likely* Sinus Rhythm
  - No p waves + Irregularly Irregular → Atrial Fibrillation
- **Step 3: Wide or Narrow?**
  - Narrow QRS (<120ms; 3 small boxes)
    - i. His-Purkinje system works and No bundle branch blocks present
    - ii. The only way you get a narrow QRS is if conduction goes through the AV node → bundle branches →Purkinje fibers (normally).
  - Wide QRS
    - i. Most likely → bundle branch block
    - ii. Ventricular rhythm → (i.e. Ventricular Tachycardia, Ventricular Fibrillation)
- **Step 4: Check the Intervals?**
  - PR (normal <200ms = 5 small boxes = 1 big box)
    - i. Prolonged in AV block
      1. Constant PR + No drop beat → 1st degree AV Block
      2. Progressive PR Prolongation + Drop Beat → Mobitz I (2nd degree AV Block)
      3. Constant PR + Drop Beat → Mobitz II (2nd degree AV Block)
      4. Complete AV Dissociation (no relationship between P waves and QRS) → 3rd degree AV Block (complete)
  - QT (normal <1/2 R-R interval)
- **Step 5: ST segments?**
  - T wave abnormalities
    - i. Inverted → ischemia
    - ii. Peaked → Early ischemia, hyperkalemia (↑K)
    - iii. Flat/U waves → Hypokalemia (↓K)
  - ST Depression → Subendocardial (partial) Ischemia or infarction (Angina or NSTEMI)
  - ST Elevation → Transmural (complete) ischemia or infarction (STEMI or Vasospastic Angina)

Summary (1/2)

Extra slide

Video:
Summary 1/2
11:25 - 26:55

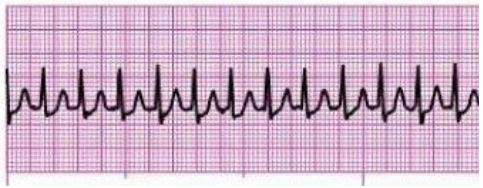
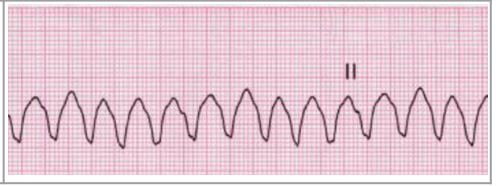
Arrhythmia	ECG Features	Picture
Sinus Rhythm (not arrhythmia)	P waves present + Regular RR "Every QRS is preceded by p wave"	
Sinus Arrhythmia	P waves present + Irregular RR *(due to respiratory cycles, everything else is normal)*	
Atrial Fibrillation	No p-waves + Irregularly Irregular RR	
Atrial Flutter	Saw Tooth Appearance	
Ventricular Fibrillation	No discernible rhythm/ waves (شخابيط)	

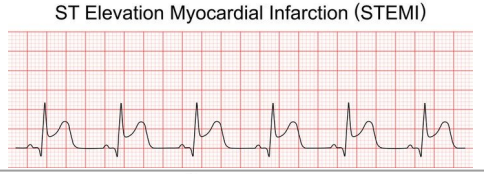
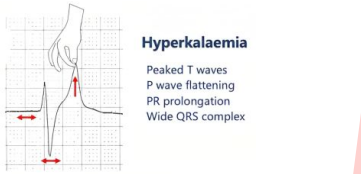
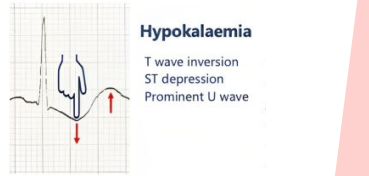
Arrhythmia	ECG Features	Picture
SA Block	absence of the P wave	
1st degree AV Block (PR prolonged - All conducted)	Prolonged PR + all P waves conducted	
Mobitz I (2nd degree AV Block) (some p waves conducted some not)	progressive lengthening of the PR interval until a beat is dropped (regularly irregular / grouped beating)	
Mobitz II (2nd degree AV Block) (some p waves conducted some not)	dropped beats + Constant PR interval	
3rd degree AV Block (complete block)	AV dissociation: no relationship between P waves and QRS complexes (Regular RR + Regular PP)	

Summary (2/2)

Extra slide

Video:
Summary 2/2
26:55 - 41:20

Arrhythmia	ECG Features	Picture
PACs (Premature Atrial Contractions	Sinus rhythm then → Early P wave + Narrow QRS complex	
PVCs (Premature Ventricular Contractions)	Sinus Rhythm then → Early Wide QRS + no p wave	
SVT (Supraventricular Tachycardia)	No p wave (hidden) + Regular RR + Narrow QRS Tachycardia	
VT (Ventricular Tachycardia)	Regular RR + Wide QRS Tachycardia	

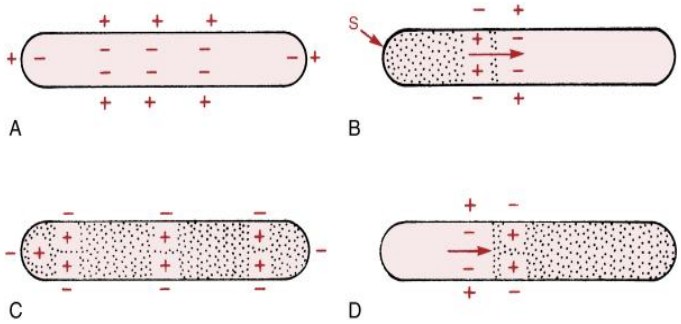
Arrhythmia	ECG Features	Picture
Subendocardial (partial) Ischemia/ Infarction	ST Segment Depression and/or T-Wave Inversion	
Transmural (complete) Ischemia/ Infarction	ST Segment Elevation	
Hyperkalemia	Peaked T-wave - Wide QRS - p wave flattening	
Hypokalemia	Flat or Inverted T Wave - Prominent U Wave	

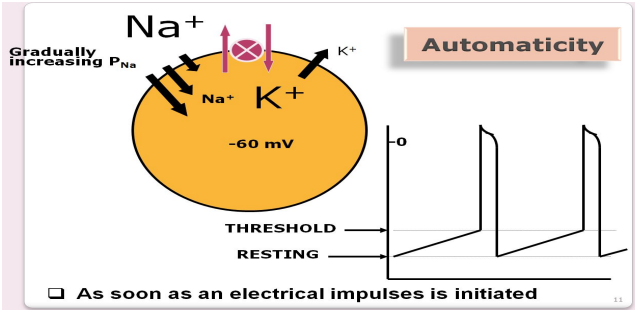
2

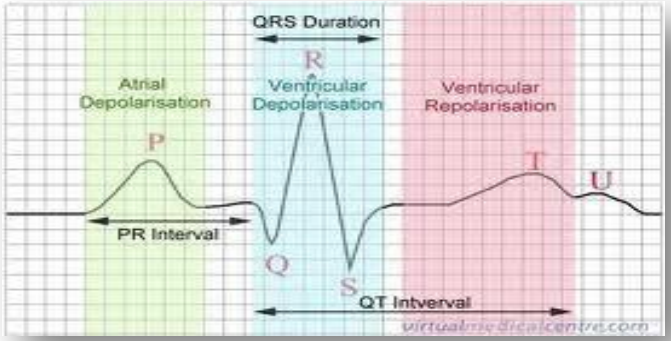
Quick Review

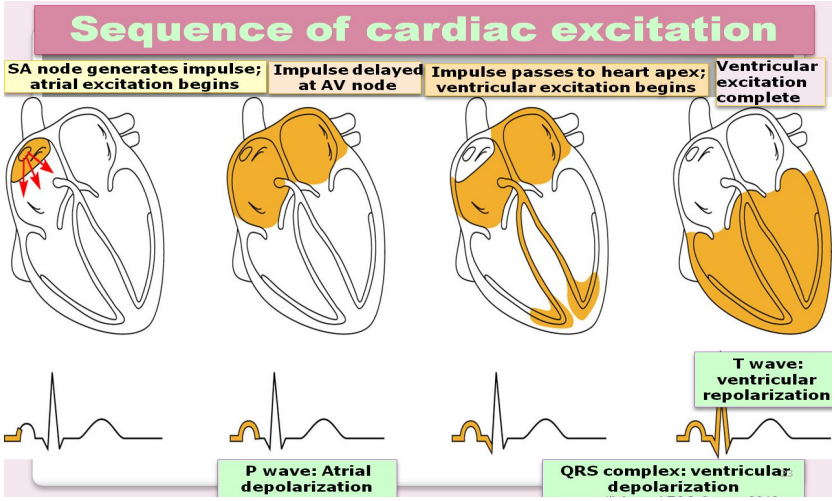
The pictures in this section are in slides but not in lecture objectives so just skim them as a review

Depolarization and Repolarization









Electrical conduction and normal conduction system

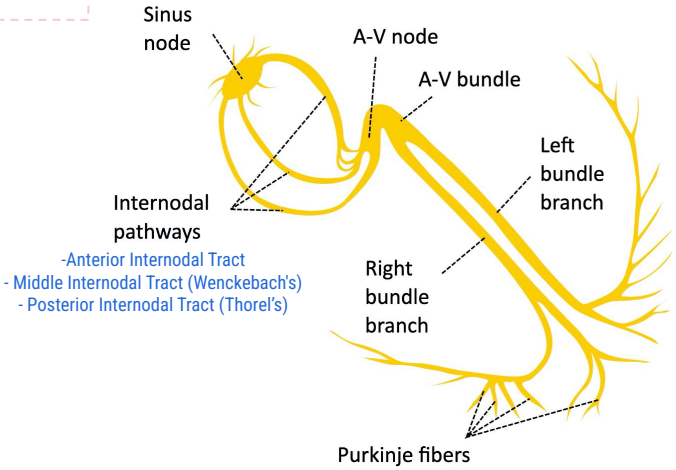
SA Node → Internodal & Interatrial Pathway → AV Node → Bundle of His → Right & Left Bundle Branches → Purkinje Fibers

Potential areas capable of beginning cardiac conduction (SA node, AV node, Purkinje Fibers)

1 **SA Node:**
60-100 BPM (AVG:70)

2 **AV Node:**
45-60 BPM

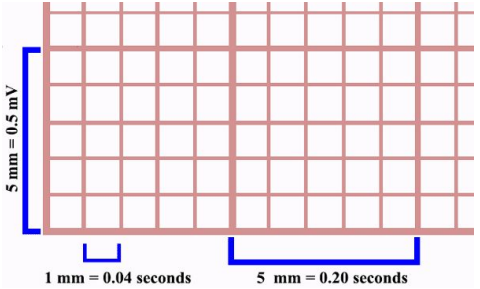
3 **Purkinje Fibers:**
15-45 BPM



Male slides

Sequence of Cardiac Excitation

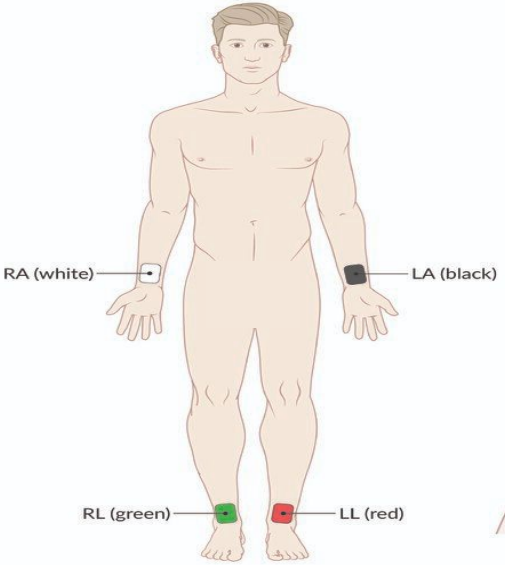
1 Small Box on X-axis = 0.04s = 40ms
1 Big Box on X-axis = 5 small boxes = 0.2s = 200ms



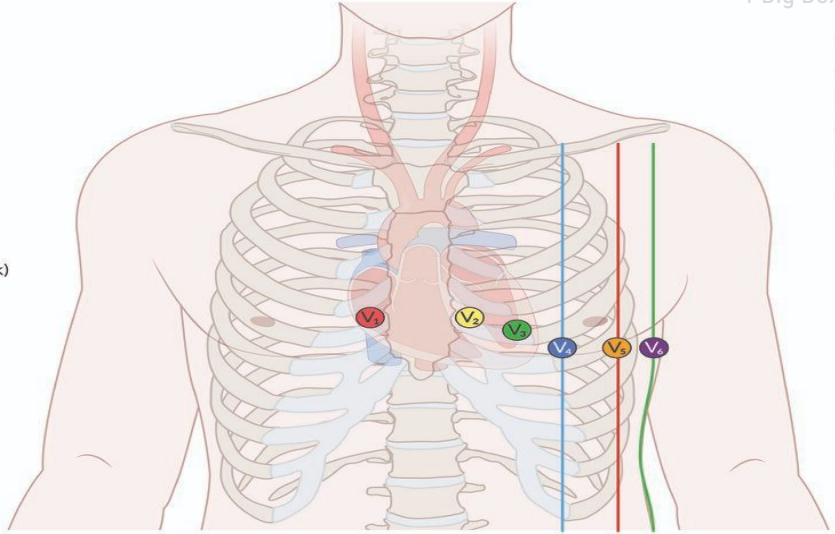
1 Small Box on Y-axis = 0.1mv = 1mm
1 Big Box on Y-axis = 5 small boxes = 0.5mv = 5mm

These exact pictures were not in slides, we added better quality ones

Limb leads



Chest leads



V_1 4th intercostal space, right sternal border
V_2 4th intercostal space, left sternal border
V_3 Midway between V_2 and V_4
V_4 5th intercostal space, left midclavicular line
V_5 Left anterior axillary line, same level as V_4
V_6 Left midaxillary line, same level as V_4 and V_5

RL (green): right leg, slightly proximal to ankle
RA (white): right arm, slightly proximal to wrist
LL (red): left leg, slightly proximal to ankle
LA (black): left arm, slightly proximal to wrist

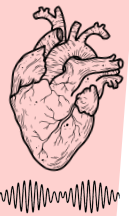
These were not mentioned here but know them for physiology lecture

3

Sinus Rhythm

This section is just to understand what normal rhythm look like.

“If you know what’s normal, then you know what’s abnormal” - someone smart



Normal Sinus Rhythm

Regular
(Constant R-R interval)

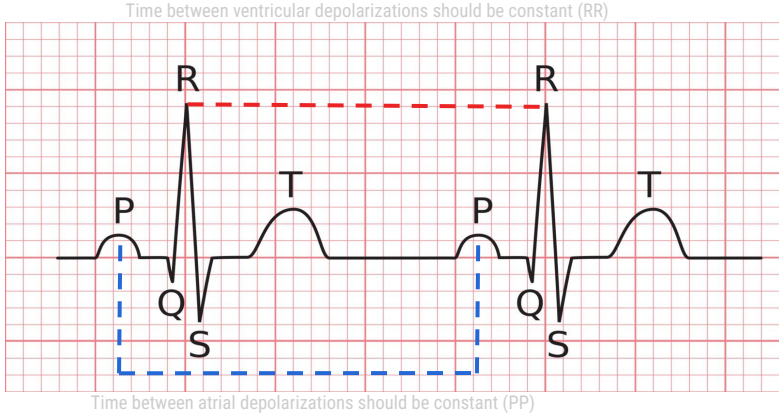
P-R interval is constant
and within normal range

Originating from
SA node

Single p-wave precedes
every QRS complex

P-P interval is constant

P wave in same
direction as QRS



Interpretation & Rate

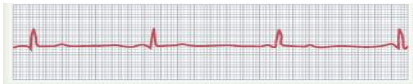
Female slides

Approach to ECG	Method
Rate (60-100 -> Normal)	a) Regular R-R Interval - **300/#big boxes** between R-R interval b) Irregular R-R Interval - Count all **R waves** then **multiply by 6** (each strip is 10 sec)
Rhythm (including intervals and blocks)	Anything other than previous slide (Sinus Rhythm) is considered **abnormal rhythm**
Axis	Not mentioned in slides (but for your own information watch this ***video***)
Hypertrophy	-
Ischemia	ST segment changes

Number of big boxes	Rate
1	300 bpm
2	150 bpm
3	100 bpm
4	75 bpm
5	60 bpm
6	50 bpm

Abnormal Sinus Rhythm

You can try it yourself (take a deep inspiration and you will feel your heart beating faster, expire and you will see it going slower)

	Tachycardia an increase in the heart rate	**Bradycardia**	**Sinus Arrhythmia**
Rate	Heart Rate > 100 Beats Per Minute (Normal = 60-100)	Heart Rate < 60 Beats Per Minute (Normal = 60-100)	A variation of the heart rate during respiration*(R-R Intervals are irregular)*, which is normal and common in young adults.
Causes	- Sympathetic stimulation - Increased Body temperature - Drugs: digitalis - Inspiration	- Parasympathetic stimulation - Expiration	- Result from spillover of signals from the medullary respiratory center into the adjacent vasomotor center during **inspiration and expiratory cycles** of respiration. - The spillover signals cause alternate increase and decrease in the number of impulses transmitted through the sympathetic and vagus nerves to the heart
Picture			

4

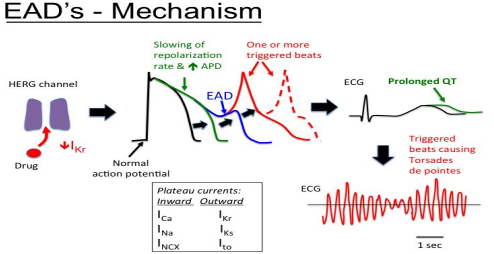
Overview of Arrhythmias

Here we cover basic mechanisms of arrhythmias. In addition to how they are classified

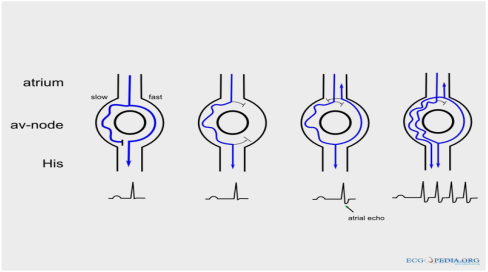
Causes/Mechanisms of Cardiac Arrhythmias

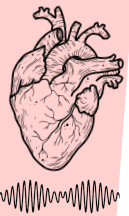
1. Abnormal rhythmicity of the pacemaker
2. Shift of the pacemaker from the sinus node to another place in the heart
3. Blocks at different points in the spread of impulse through the heart
4. Trigger
5. Reentry
6. Abnormal pathways of impulse transmission through the heart
7. Spontaneous generation of spurious impulses in almost any part of the heart

This is the mechanism of torsades de pointes



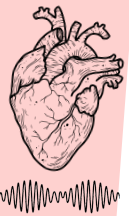
This is the mechanism of Reentry (AVNRT)





Classification / Causes of Cardiac Arrhythmias

- Rate Above or Below Normal (Tachyarrhythmias vs. Bradyarrhythmias)
- Regular or irregular rhythm
- Narrow or Broad Rhythm QRS Complex
  (**Narrow** QRS = **Fast** ventricular depolarization = conduction went through Bundle branches→ purkinje → myocytes) | (**Wide** QRS = **Slow** Ventricular Depolarization)
- Relation to P Waves (absent p waves?)
- Supraventricular vs. Ventricular (Supraventricular = originates above AV node) | (Ventricular = originates below AV node)

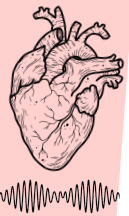


COMMON ARRHYTHMIAS

Female's slide

This table is only female slides and in our opinion it's not important to memorize all.Because some are not even mentioned in next slides.

Origin	Bradyarrhythmia	Tachyarrhythmia
SA node	- Sinus Bradycardia - Sick Sinus Syndrome	- Sinus Tachycardia
Atria		- Atrial Premature Beats - Atrial Flutter - Atrial Fibrillation - Paroxysmal SVT - Multifocal Atrial Tachycardia
AV node	- Conduction Blocks (1st,2nd, 3rd) - Junctional escape rhythm	-
Ventricles	- Ventricular Escape Rhythm	- Ventricular Premature Beats - Ventricular Tachycardia - Torsades de pointes - Ventricular Fibrillation



Differential Diagnosis of Tachycardia

Female's slide

This table is only female slides and in our opinion it's not important to memorize all.Because some are not even mentioned in next slides.

Tachycardia	Narrow Complex	Wide Complex
Regular	• Sinus Tachycardia • Supraventricular Tachycardia • Atrial Flutter	• Sinus Tachycardia with aberrancy • Supraventricular Tachycardia with aberrancy • Ventricular Tachycardia
Irregular	• Atrial Fibrillation • Atrial Flutter with variable conduction • Multifocal Atrial Tachycardia	• Atrial Fibrillation with aberrancy • Atrial Fibrillation with WPW • Ventricular Tachycardia

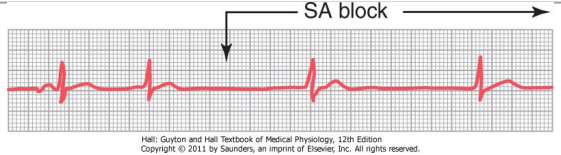
5

Conduction Blocks

*SA node →(block)→ Atrial Muscle = **SA Block** (no p wave)*

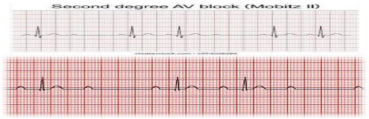
*SA node → Atrial Muscle → AV node + His Purkinje system →(block)→Ventricle = **Atrioventricular (AV) block** (PR interval abnormal)*

Abnormal Cardiac Rhythms that Result from Impulse Conduction Block

	Sinoatrial (SA) Block	A-V (heart) Block
What is Blocked?	- The impulse from the S-A node is blocked before it enters the atrial muscle	When impulse from the AV node is blocked
Causes	- Ischemia of the node - Compression of the A-V node by Scar Formation - Inflammation of the A-V node (Aging) - Strong vagal stimulation	
Pictures		-
Characteristics	Cessation of P Wave	1st, 2nd, 3rd degree block

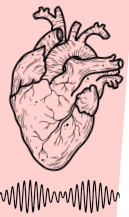
1st, 2nd & 3rd Degree A-V Block

1 Small Box = 0.04s = 40ms
1 Big Box = 5 small boxes = 0.2s = 200ms

AV Block		Description	ECG Pattern			Picture
			P-R Interval Duration (Prolonged when > 0.2s or 1 big box)	Constant or Progressive P-R Interval?	Is a Drop Beat Present? (P wave not followed by QRS)	
First Degree		1st Degree = Prolonged PR	Prolonged	Constant	Without Drop Beat	
Second Degree	Mobitz (I) (Physiological)	- 2nd degree = prolonged PR + Drop Beat - Drop Beat mechanism: Only few impulses pass to the ventricles→ Atria beat faster than ventricles → "dropped beat" of the ventricles	Prolonged	Progressive	With Drop Beat	
	Mobitz (II) (Pathological)		Prolonged	Constant	With Drop Beat	
Third Degree		- The ventricle escape from the influence of S-A node. - Pathological Condition Related : Stokes-Adams Syndrome : AV Block comes and goes.	Complete dissociation of P wave and QRS waves (Atrial Rate is 100 beats/min) | (Ventricular Rate is 40 beats/min)			- (P-P interval is constant) | (R-R interval is constant) | (no relationship between P waves and QRS complexes) 

6

Premature Contractions (PACs/PVCs)



Premature Contractions (Ectopic beat)

Female's slides

What's it?

Contractions that occur early before the next normal sinus impulse (before P wave send the impulse out), thus we'll see QRS complex occurs prior to the next expected beat.

Results from?

Premature contractions (Extrasystoles) or ectopic beat result from ectopic foci that generate abnormal cardiac impulses (Pulse deficit).

Originate in?

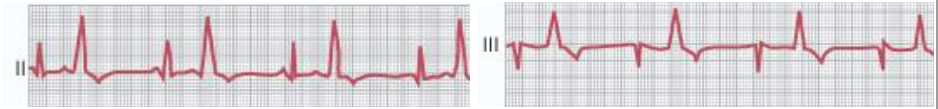
Ectopic foci can cause premature contractions that originate in: The atria (but not in SA node), A-V junction, The ventricles.

Causes?

Ischemia, Irritation of cardiac muscle by calcified foci, Drugs like caffeine

Premature Contractions (Ectopic beat)

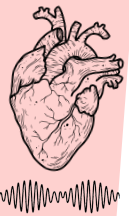
Female's slides

Premature Contractions	PACs (Premature Atrial Contractions)	PVCs (Premature Ventricular Contractions) Causes: Drugs, Caffeine, Smoking, Lack of Sleep, Emotional Irritations.
QRS Complex	Normal Narrow QRS because impulse went through AV node → Bundle of HIS →Purkinje system	• Prolonged QRS Complex: because the impulses are carried out with myocardial fibers with slower conduction rate than Purkinje fibers. • Increase QRS Complexes Voltage: because QRS wave from one ventricle can not neutralize the one from the other ventricle
Features	• Short P-R Interval: Depending on how far the ectopic foci from the AV node. • Pulse Deficit: If there is no time for the ventricles to fill with blood. • Compensatory Pause: The time between the premature contraction and the succeeding (next) beat is increased.	• T Wave has an electrical potential of opposite polarity of that of the QRS: because of the slow conduction in the myocardial fibers, the fibers that depolarizes first will Repolarize first.
Picture		

7

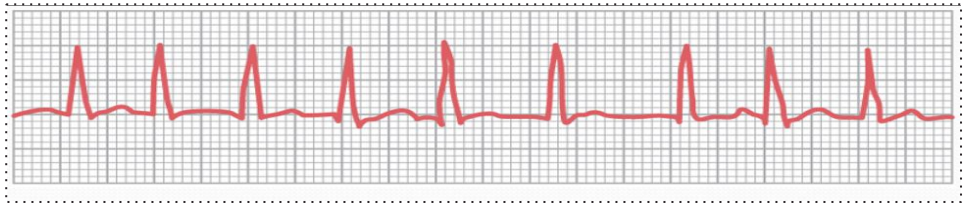
Fibrillation / Flutter

Atrial Fibrillation is the most common arrhythmia



Atrial Fibrillation

Cause / mechanism	Same mechanism as Ventricular FIbrillation - it can occur only in atria without affecting the ventricles - The Atria do not pump if they are fibrillating - The efficiency of ventricles pumping/filling is decreased 20-30%, thus the cardiac output will decrease 20-30%
Features	No P wave, or high frequency of low voltage P wave Irregularly irregular (means its irregularity doesn't have a pattern) Narrow QRS complex
Causes	It occurs more frequently in patients with enlarged heart
Treatment	DC shock

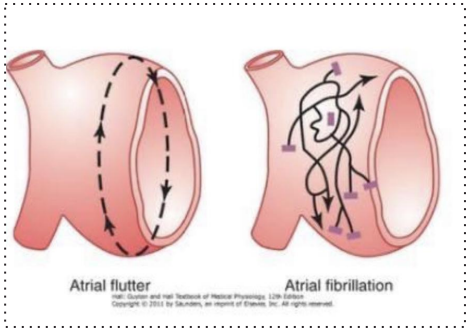


Notice: No discernable P wave + irregular RR interval

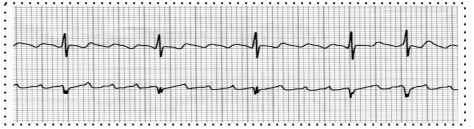
Atrial Flutter

14:35-16:05

A single large wave travels around and around in the atria
(notice in the picture that atrial fibrillation has multiple impulses generated from different locations, while the atrial flutter has only one that is large) (Reentry Circuit)
(It's more organized than Atrial Fibrillation)



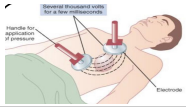
- Atrial Rate : The Atria contracts at high rate (250 bpm/min)
- Amount of Blood : Because one area of the atria is contracted and another one is relaxed, the amount of blood pumped by the atria is slight
- Rhythm : The refractory period of the AV node causes 2-3 beats of atria for one single ventricular beat ; 2:1 or 2:3 rhythm.

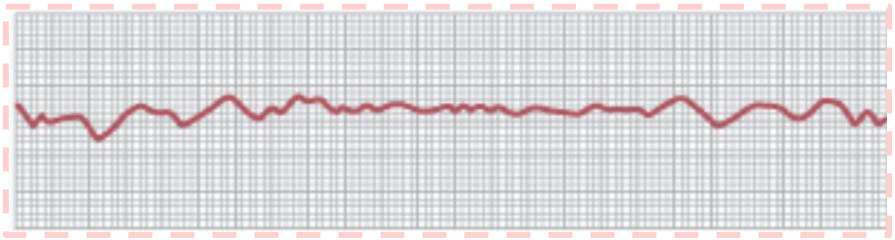


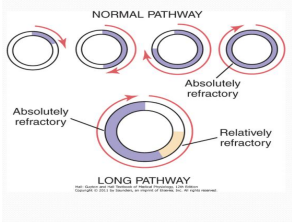
Saw-tooth Appearance- Narrow QRS Complex

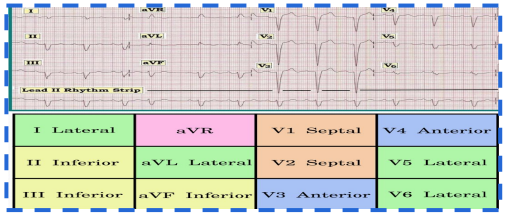
Ventricular Fibrillation

The most serious of all arrhythmias

Cause	impulses stimulate one part of the ventricles, then another, then itself, many parts contract at the same time while other parts relax (circus movement)
Features	Tachycardia, Irregular rhythm, Broad QRS complex, No P wave, low amplitudes, Chaotic and rapid rate
Causes	Sudden Electrical Shock, Ischemia
Treatment	DC shock 





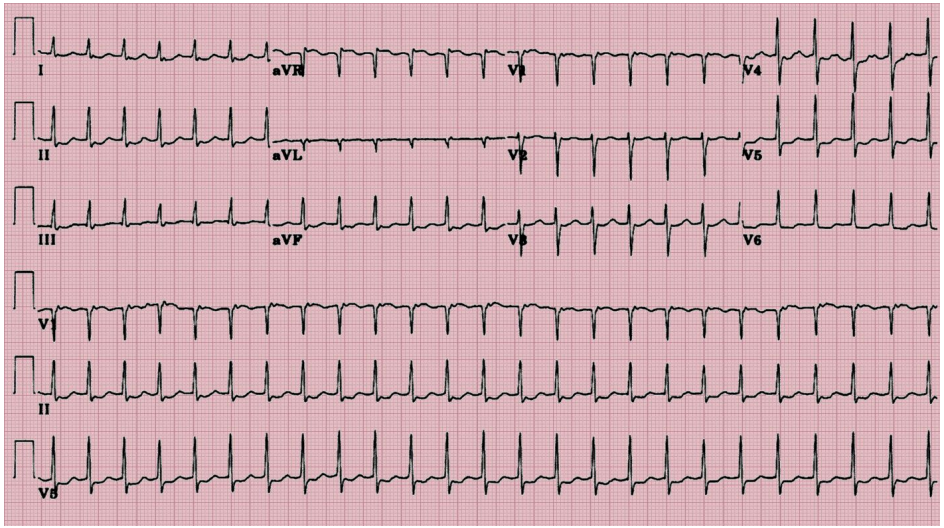


No p waves and the whole baseline is fibrillatory. Yes slides says its wide QRS, because it's a ventricular rhythm. But actually all the waves in VFib are indiscernible.

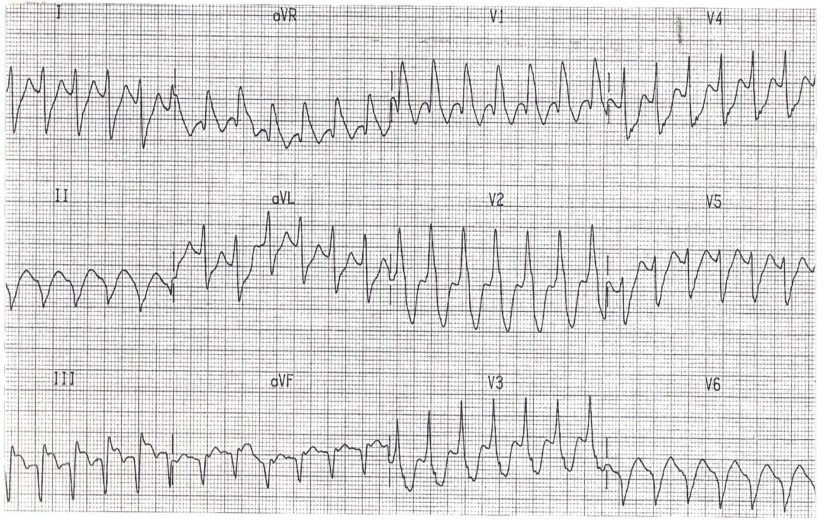
SVT and VT

Male's slides

AVRT-Narrow Complex
(Supraventricular Tachycardia - SVT)



Ventricular Tachycardia
(Wide Complex)



8

Ischemia/Potassium & The ECG

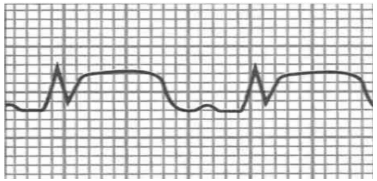
This section in slides, but M&F doctors hinted it may not come. Still its mentioned in other lectures (Physiology) and it's not very hard to grasp the basics

Ischemia And The ECG

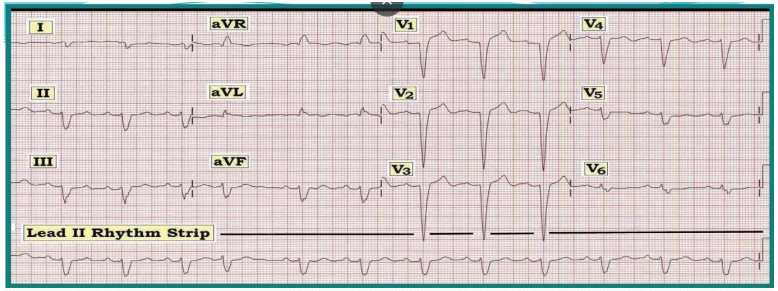
Extra slide

Ischemia = Decreased blood flow to the heart.

It has two types:

1- Reversible: **Angina Pectoris**	2- Irreversible: **Myocardial Infarction** • Complete loss of blood supply to the myocardium resulting in necrosis or death of tissue ○ Ischemia -> Injury -> Infarction
Inverted T Wave - ST Segment depression	ST Segment Elevation - Deep Q Wave STEMI : ST-Elevation Myocardial Infarction
	

One of the common uses of the ECG is in acute assessment of chest pain.



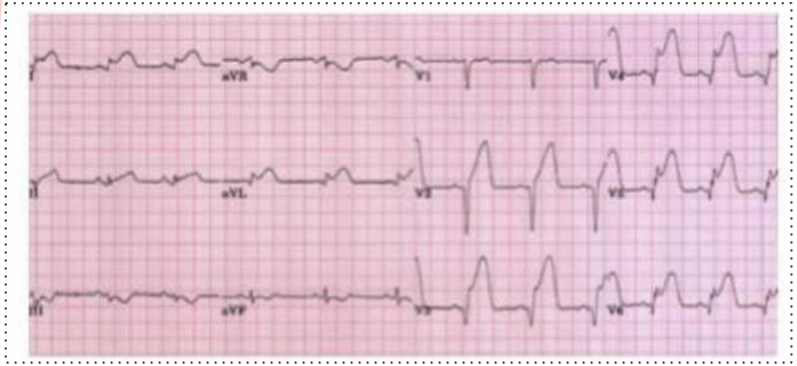
I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

Ischemia And The ECG Cont..

Extra slide

7:05 - 6:18

Antero-Lateral MI



- Occlusion of the Left Anterior Descending Artery (LAD)
- ST elevation in leads V2-V6, I, aVL
- Reciprocal ST depression in leads III, aVF

6:18 - 5:05

Infero-Posterior MI

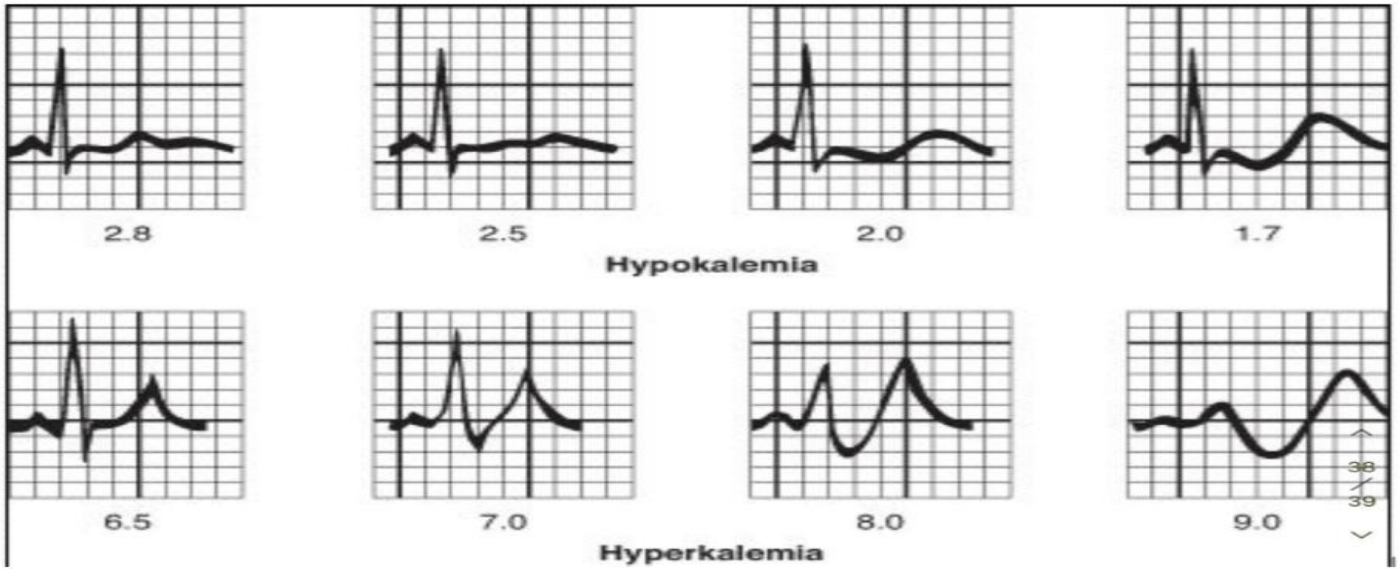
- Occlusion of the Right Coronary Artery (RCA)
- ST elevation in leads II, III, aVF
- Reciprocal ST depression in aVL

Extra slide

Potassium and the ECG

Hypokalemia:
- Flat T Wave

Hyperkalemia:
- Tall Peaked T Wave



8

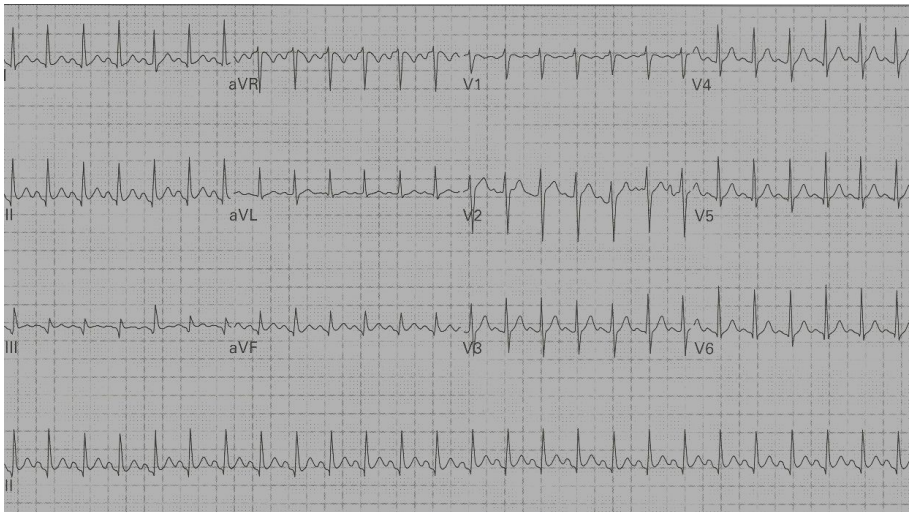
Questions

In a 12-Lead ECG the best lead to assess most things (rhythm, p wave, PR interval) is Lead II. so look at it first

MCQ

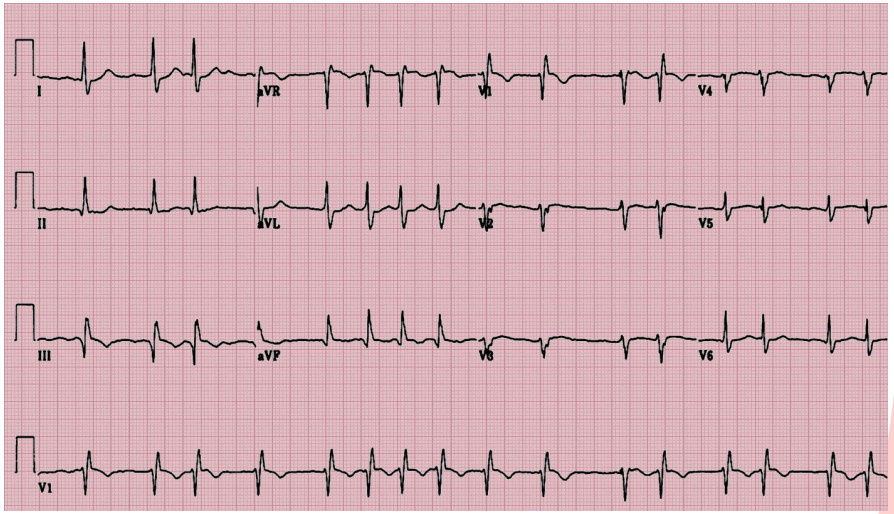
Video:
Questions
41:20 - 51:01

1) 24 year-old pregnant woman with three days of frequent vomiting?



A) SVT
B) VT
C) Sinus Tachycardia
D) Atrial Flutter

2) What do you see in this ECG?



A) Atrial Flutter
B) Atrial Fibrillation
C) SA Block
D) Sinus Tachycardia

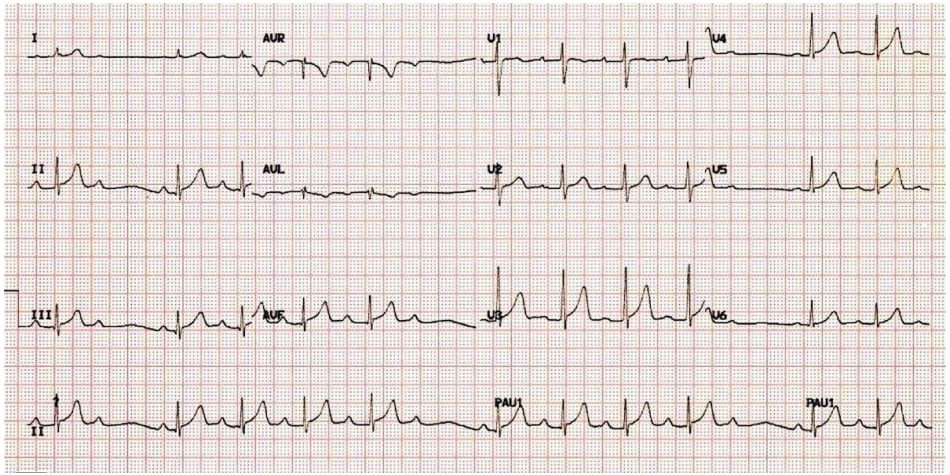
Answers

1/C
2/B

MCQ

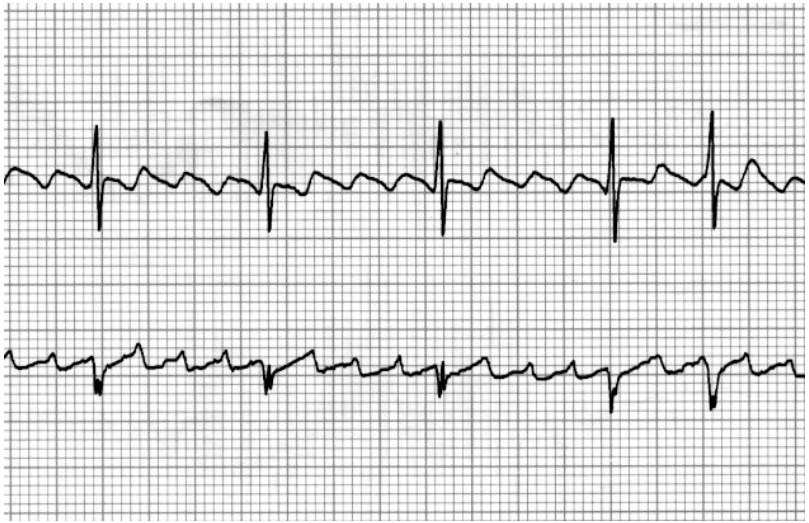
Video:
Questions
41:20 - 51:01

What do you see in this ECG



A) 1st degree AV Block
B) 2nd degree AV Block
C) 3rd degree AV Block
D) Sinus Bradycardia

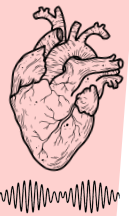
What do you see in this ECG?



A) Atrial Flutter
B) Atrial Fibrillation
C) PAC
D) SVT

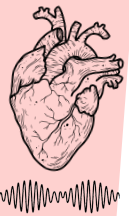
Answers

1/B
2/A



SAQ

Questions:	Answers:
Q1: Why does sinus arrhythmia occur?	Due to the changes in autonomic tone during respiratory cycles
Q2: How is Atrial/Ventricular Fibrillation treated?	DC shock
Q3: Premature Contractions (Ectopic beat) originate in?	Ectopic foci can cause premature contractions that originate in: The atria (but not in SA node), A-V junction, The ventricles.
Q4: give features of ventricular fibrillation?	Tachycardia, Irregular rhythm, Broad QRS complex, No P wave



Meet Our Team

MED44

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- **Team Members:**

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شادن راضي الشمري