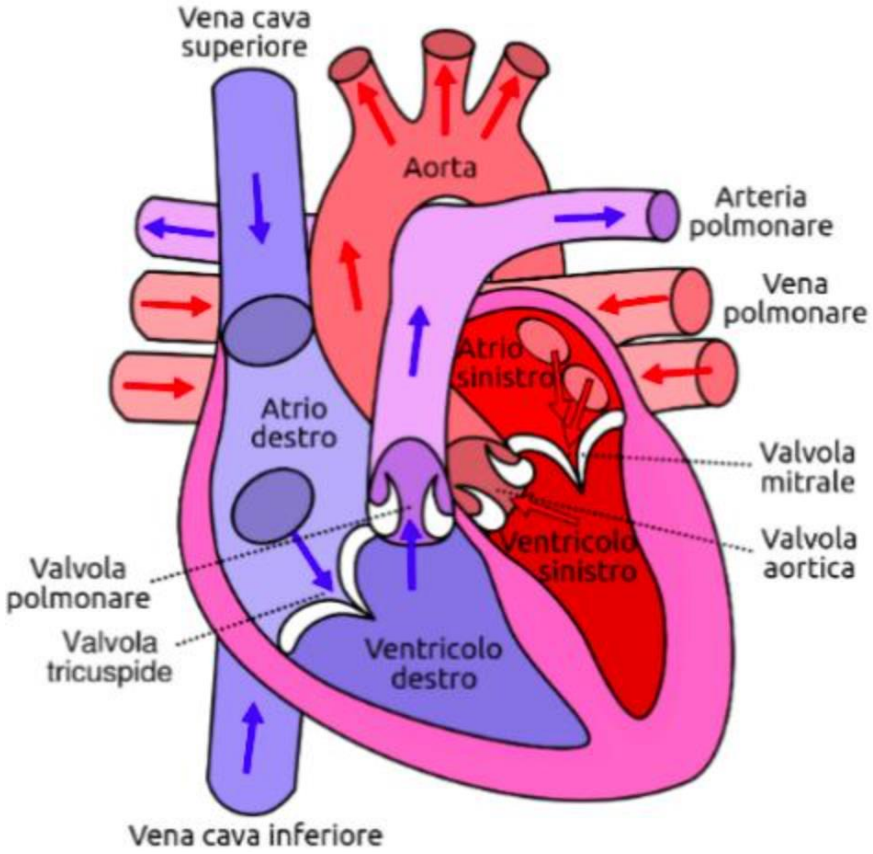
Lab session n°2

The electrocardiogram for measuring heart rate



PULMONARY CIRCULATION

Function

To oxygenate the blood.

1.Right ventricle → venous blood (low in O_2)

Blood leaves through the **pulmonary artery** toward the lungs.

2.Lungs

In the alveolar capillaries, the blood releases CO_2 and takes up O_2.

3.Pulmonary veins → left atrium

The blood, now arterial (rich in O_2), returns to the heart through the **pulmonary veins** and reaches the left atrium.

SYSTEMIC (MAJOR) CIRCULATION

Function

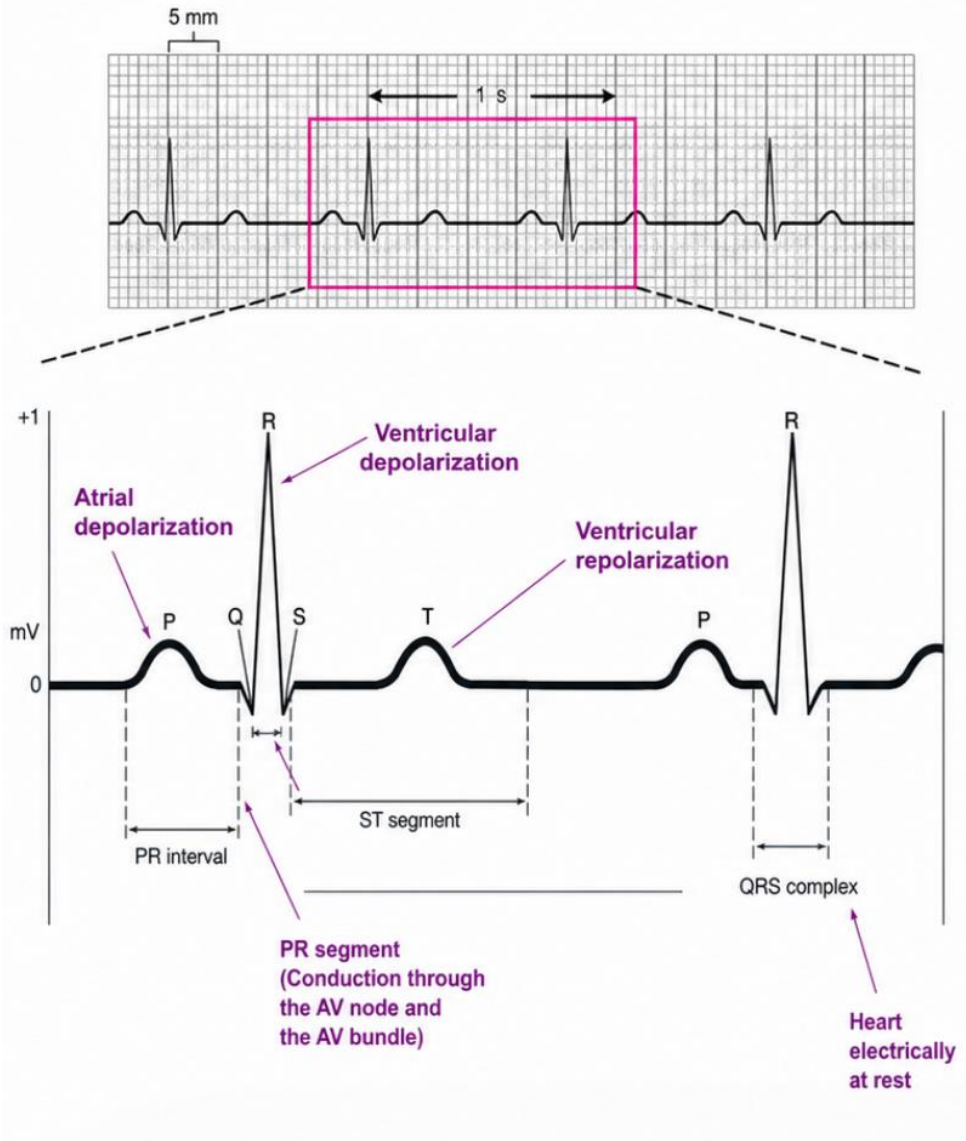
To deliver oxygenated blood to the entire body.

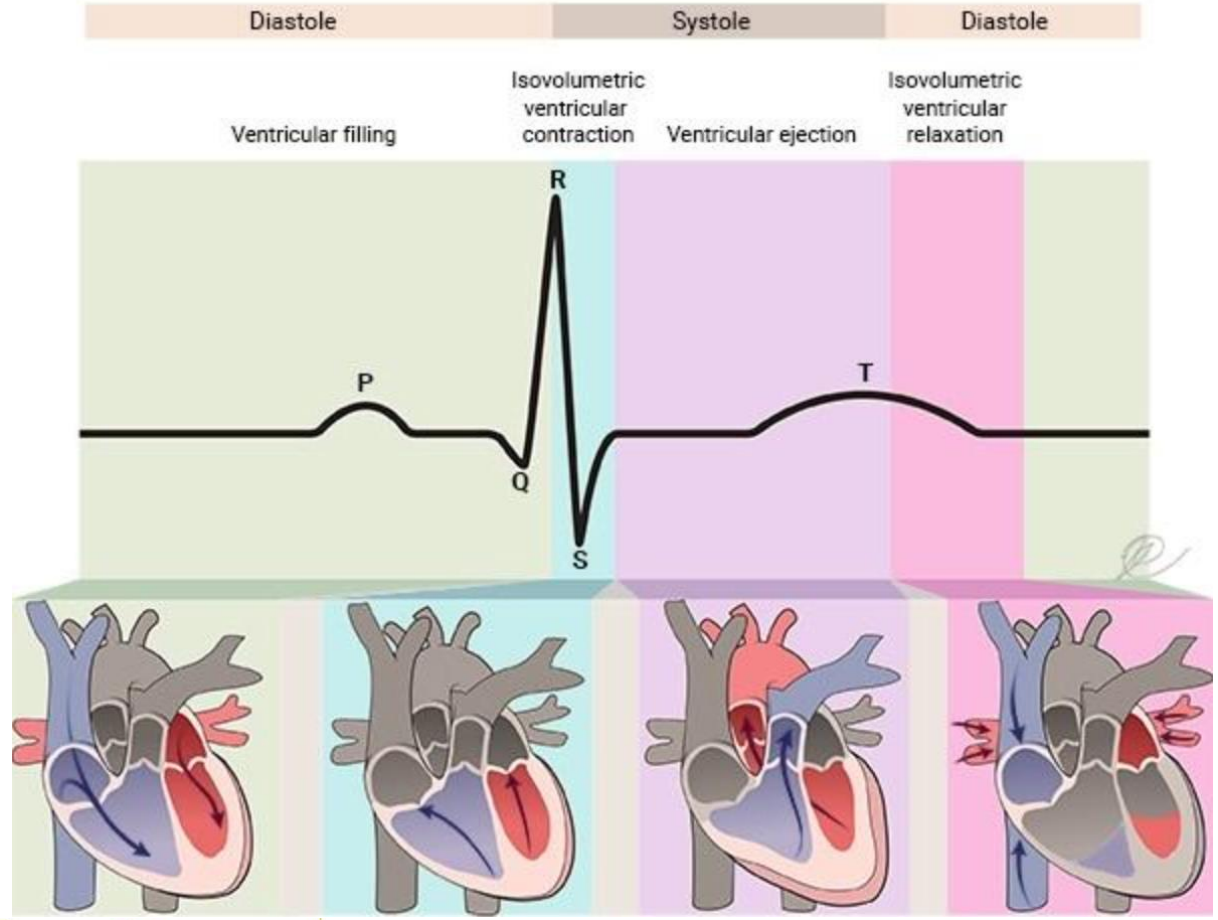
1.Blood moves from the **left atrium** to the **left ventricle**.

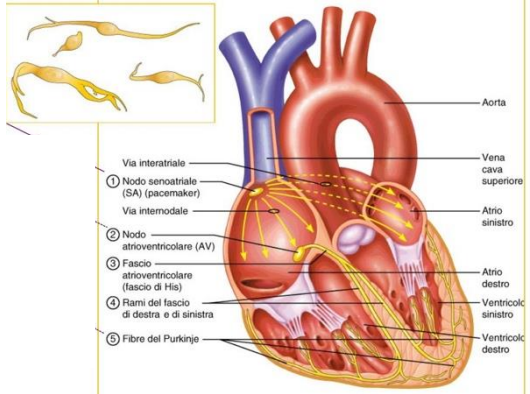
2.Left ventricle → aorta → tissues

3.Return to the right side of the heart

The blood, now venous, returns through the **vena cavae** (superior and inferior) to the right atrium, ready to begin the pulmonary circulation again.

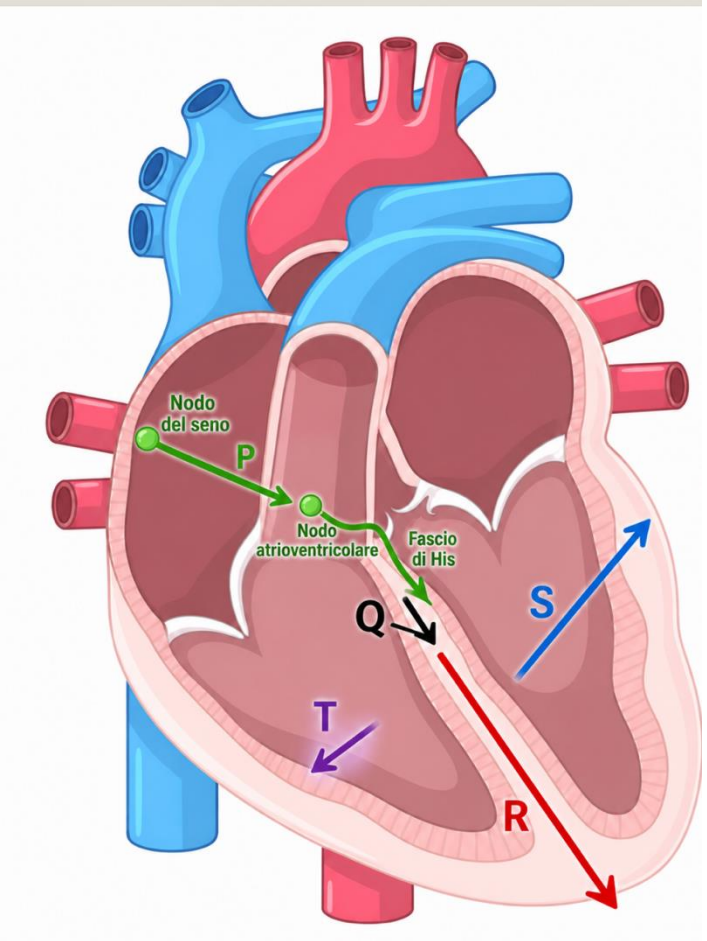

5 mm
1 s
+1
mV
0
R
Ventricular depolarization
Atrial depolarization
Ventricular repolarization
P
Q
S
T
P
R
ST segment
PR interval
QRS complex
PR segment
(Conduction through
the AV node and
the AV bundle)
Heart
electrically
at rest


Diastole
Systole
Diastole
Ventricular filling
Isovolumetric ventricular contraction
Ventricular ejection
Isovolumetric ventricular relaxation
R
P
T
Q
S


Aorta
Via interatriale
Vena cava superiore
1 Nodo senoatriale (SA) (pacemaker)
Via internodale
Atrio sinistro
2 Nodo atrioventricolare (AV)
3 Fascio atrioventricolare (fascio di His)
Atrio destro
4 Rami del fascio di destra e di sinistra
Ventricolo sinistro
5 Fibre del Purkinje
Ventricolo destro

At every moment, the heart generates a mean electrical vector, with a specific direction and orientation in space.

The arrows in the figure show how this vector is oriented during the different phases.



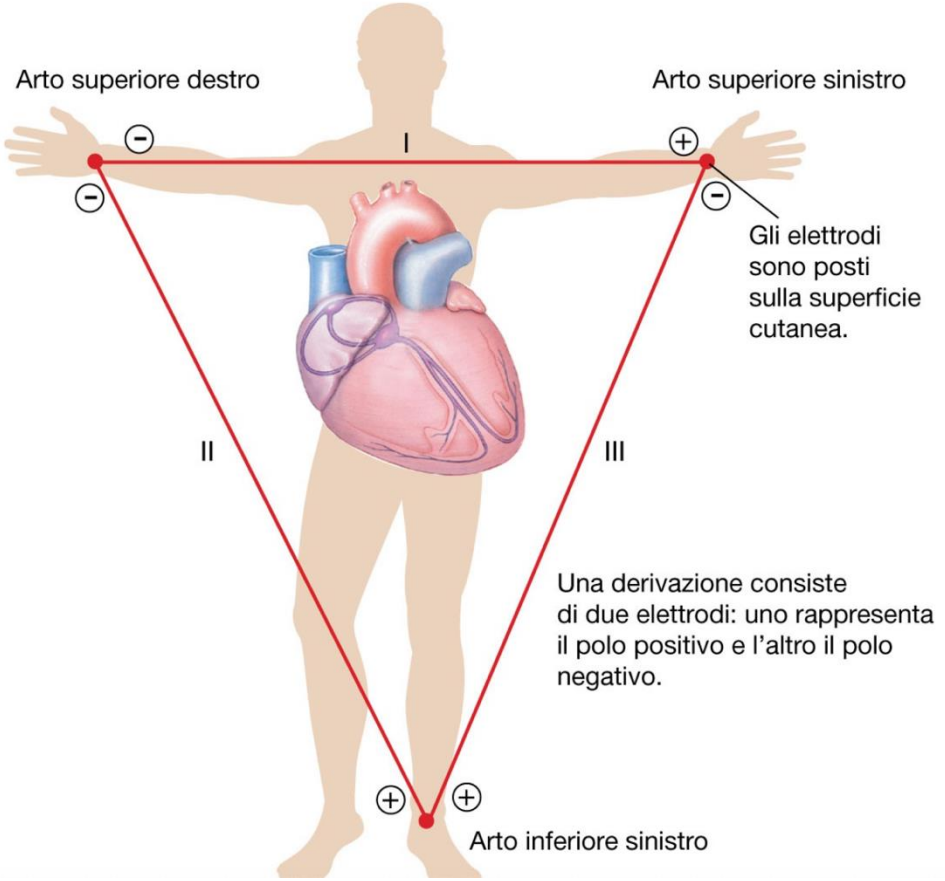
How to calculate heart rate from an ECG tracing

The paper moves at 25 mm/second.
One small square is 1 mm wide.
If 25 mm correspond to 1 second,
then 1 mm corresponds to 1/25 = 0.04 seconds.
Therefore:
1 small square = 0.04 seconds

$$\text{Heart rate BPM} = \frac{60}{\text{n° small squares} \times 0.04}$$

Seconds per minute

RR interval in seconds



- The device with finger plates still records a potential difference between two points of the body,
- It uses your two hands as the "right arm" and "left arm" and perform a single-lead ECG, like a simplified Lead I.
- The physical principle is the same: only the number of "points of view" on the same electrical phenomenon changes.

Mean =
sum of all values ÷ number of values

A Heart rate calculation (beats per minute; bpm)

Female - male	height	Life style: Sedentary – not sedentary	Average numebers of small squares in the RR interval **Count 5–6 RR intervals**	**heart rate**	Does the sinus rhythm appear regular? *

* **Does the sinus rhythm appear regular?**

1. Count the small squares in 6–8 R–R intervals.
2. Record the obtained values (RR1, RR2, RR3, …).
3. Compare the obtained values. If they differ only slightly (e.g., 20, 21, 20, 19, 20), the rhythm is considered regular.

B

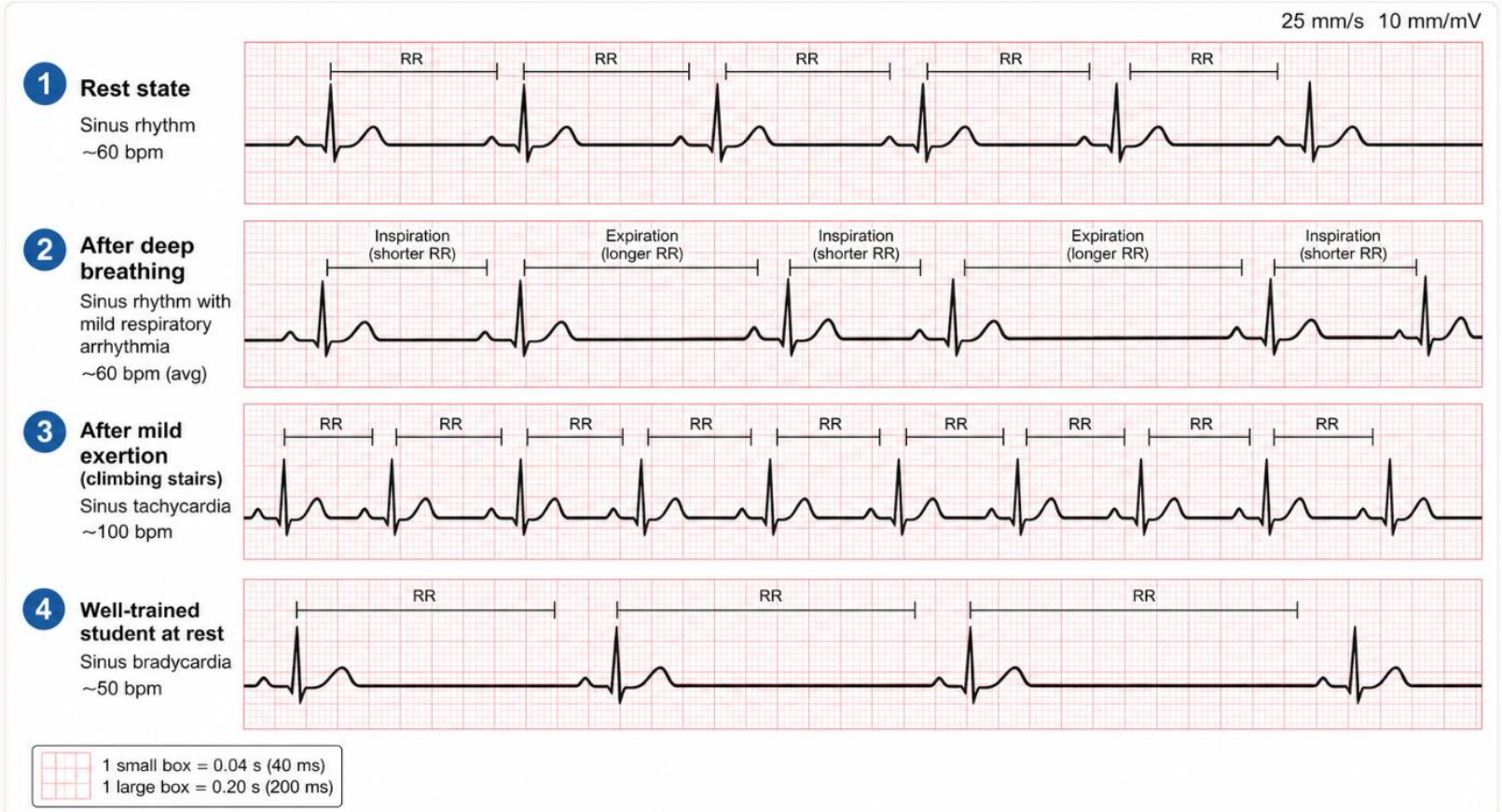
1. Which subject has the highest heart rate and which has the lowest?
2. Do more highly trained subjects have a lower resting heart rate?
3. Do the PR, QRS, and QT intervals appear similar among the subjects, or are there evident differences?

Factors Influencing Heart Rate (R–R Interval)

The distance between one R peak and the next (the R–R interval) can vary due to the action of the autonomic nervous system (ANS):
•sympathetic tone,
•vagal (parasympathetic) tone.

When vagal tone increases, the sinoatrial node slows down:
•the R–R intervals become longer.

When sympathetic activity predominates (stress, exercise, activation), the sinoatrial node speeds up:
•the R–R intervals become shorter and more uniform.



Factors Influencing the QRS Complex

Cardiac factors
Size and shape of the ventricles
Thickness and conduction in the interventricular septum (physiological factors)
Age and body size (chest size)
Position of the heart
Amount of adipose tissue

Extracardiac factors
Body position (sitting, supine, etc.)
Electrode placement
Skin impedance (skin thickness, hydration, etc.)
Lung volume (degree of thoracic expansion)