Photograph of a Complete Electrocardiograph, showing the manner in which the electrodes are attached to the patient, in this case the hands and one foot being immersed in jars of salt solution.
With EKGs we can identify

Arrhythmias
Myocardial ischemia and infarction
Pericarditis
Chamber hypertrophy
Electrolyte disturbances (i.e. hyperkalemia, hypokalemia)
Drug toxicity (i.e. digoxin and drugs which prolong the QT interval)
Pacemakers of the Heart

- **SA Node** - Dominant pacemaker with an intrinsic rate of 60 - 100 beats/minute.

- **AV Node** - Back-up pacemaker with an intrinsic rate of 40 - 60 beats/minute.

- **Ventricular cells** - Back-up pacemaker with an intrinsic rate of 20 - 45 bpm.
ECG

1. BIPOLAR LEADS I II III •
2. UNIPOLAR LIMB LEADS aVR aVL aVF •
3. UNIPOLAR CHEST LEADS •
   C1.........C6
4. RECORDING OF THE ECG •
Figure 11-2. Recording the depolarization wave (A and B) and the repolarization wave (C and D) from a cardiac muscle fiber.

The lower half of Figure 11-3 shows a simultaneous recording of the ECG from this same ventricle. Note that the QRS waves appear at the beginning of the monophasic action potential and the T wave appears at the end. Note especially that no potential is recorded in the ECG when the ventricular muscle is either completely polarized or completely depolarized. Only when the muscle is partly polarized and partly depolarized does current flow from the part of the ventricles to another part, and therefore current also flows to the surface of the body to produce the ECG.

RELATIONSHIP BETWEEN VENTRICULAR WAVES OF THE ELECTROCARDIOGRAM

Before contraction, muscle fibers that constitute the atria and the ventricles must spread through the processes of excitation. When depolarization of the atria occurs, the atrial P wave occurs on the ECG. Depolarization of the ventricles occurs when the atrial T wave of the atrial complex begins. The atrial T wave is often the first negative deflection in the ventricular electrocardiogram (ECG).

The atrial complex may persist for a short time after the ventricles have depolarized completely, and the normal ECG reflects this by the atrial T wave, which is often seen as a prolonged negative deflection in the ventricular complex. For this reason, the atrial T wave is often the first negative deflection in the ventricular complex.
Figure 11-3. Top, Monophasic action potential from muscle fiber during normal cardiac function showing depolarization and then repolarization occurring slowly during the depolarization but rapidly toward the end. Bottom, Electrocardiograms recorded simultaneously.
Einthoven's Lead System

The electrocardiogram (ECG) is a recording of the electrical activity of the heart. The ECG is recorded using electrodes that are placed on the skin at various locations on the body. The electrical activity of the heart is recorded by connecting these electrodes to an amplifier that amplifies the electrical signals and a recorder that records the amplified signals.

Lead I

Lead I is recorded by connecting the positive terminal of the amplifier to the left arm and the negative terminal to the right arm. The lead is referred to as lead I because the positive terminal is on the left arm and the negative terminal is on the right arm. Lead I is also known as the horizontal lead because the electrodes are positioned horizontally on the body. Lead I records the electrical activity of the heart in the horizontal plane.

Lead II

Lead II is recorded by connecting the positive terminal of the amplifier to the right arm and the negative terminal to the left leg. The lead is referred to as lead II because the positive terminal is on the right arm and the negative terminal is on the left leg. Lead II is also known as the frontal lead because the electrodes are positioned vertically on the body. Lead II records the electrical activity of the heart in the frontal plane.

Lead III

Lead III is recorded by connecting the positive terminal of the amplifier to the left arm and the negative terminal to the left leg. The lead is referred to as lead III because the positive terminal is on the left arm and the negative terminal is on the left leg. Lead III is also known as the sagittal lead because the electrodes are positioned horizontally on the body. Lead III records the electrical activity of the heart in the sagittal plane.

The ECG is recorded using three leads: lead I, lead II, and lead III. The ECG is recorded by connecting the electrodes to the skin and then amplifying and recording the electrical signals. The ECG is a valuable tool for diagnosing various heart conditions and monitoring the electrical activity of the heart.
It should be recalled from the discussion of the Purkinje system in Chapter 10 that the cardiac impulse first arrives in the ventricles in the septum and shortly thereafter spreads to the inside surfaces of the remainder of the ventricles, as shown by the red areas and the negative deflections of the recording.

**Figure 11-5.** Flow of current in the chest around partially depolarized ventricles. A and B are electrodes.
Limb leads

Lead I:
Right arm to left arm

aVR: right arm

aVL: left arm

Lead II:
Right arm to left leg

Lead III:
Left arm to left leg

aVF: left leg

Ground electrode

Fig. 9-13a, p. 253
Einthoven

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Einthoven’s law
Einthoven’s triangle
2) Chest leads (precordial leads):
ECG

1. ECG WAVES P, QRS AND T •
2. ECG SEGMENTS PR AND ST •
3. ECG INTERVAL PR, QT AND TP •
The shape of the ECG
SINGLE VENTRICULAR ACTION POTENTIAL

ATRIAL FIBER

ENDOCARDIAL FIBER

EPICARDIAL FIBER

Depolarization of atria
Depolarization of ventricles
Repolarization of ventricles

ECG

P Q S T

1 mV
EKG Waves and Intervals

**Normal:**
- PR interval: 0.12-0.2 sec
- QRS length: <0.10 sec
- QT interval: 0.3-0.4 sec

**Abnormalities in:**
- QRS – ventricular depolarization problems
- P-R interval – A/V conduction problems
EKG Reading

HR = 1500/ small boxes between QRS complexes

1.0 mV
Test pulse

0.2 sec
0.04 sec
3) Augmented unipolar limb leads:
Relationship between No. of large squares & HR

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<th>R-R interval (large squares)</th>
<th>Heart rate (beat/min)</th>
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## Times & speed....

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