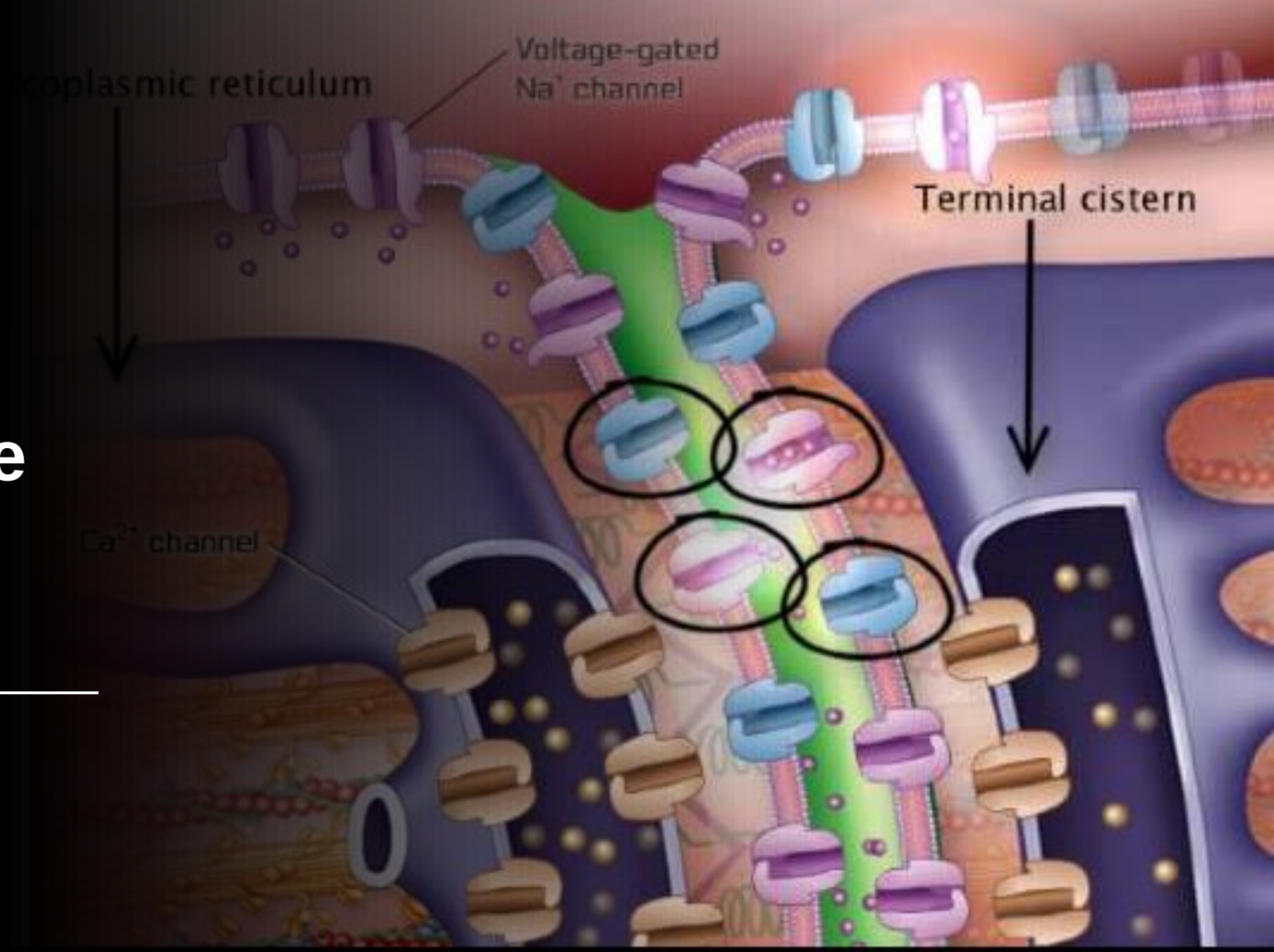
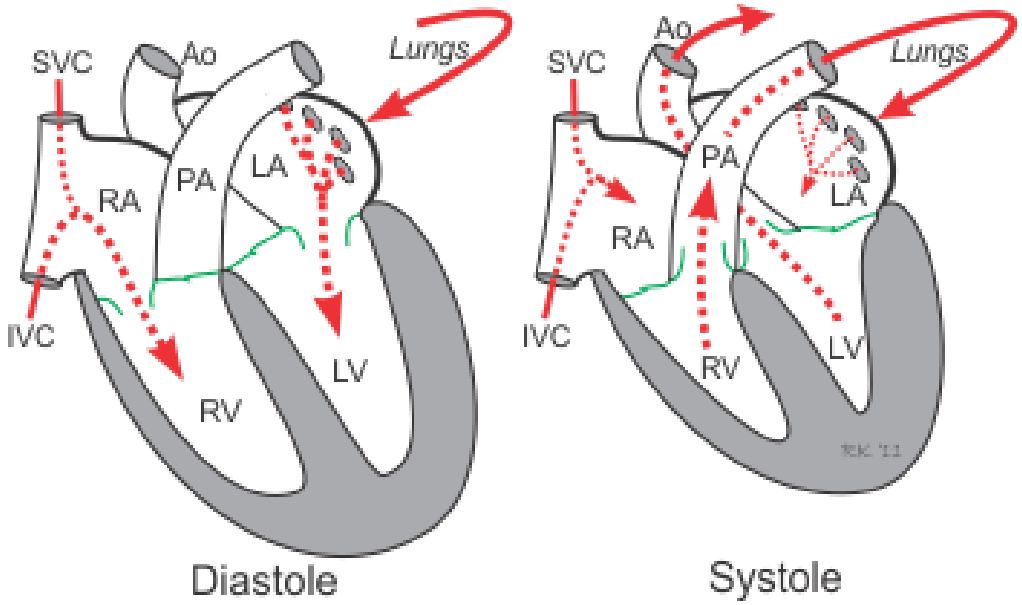
Calcium and Excitation-Contraction Coupling in the Heart



Assoc. Prof. Erkan Tuncay

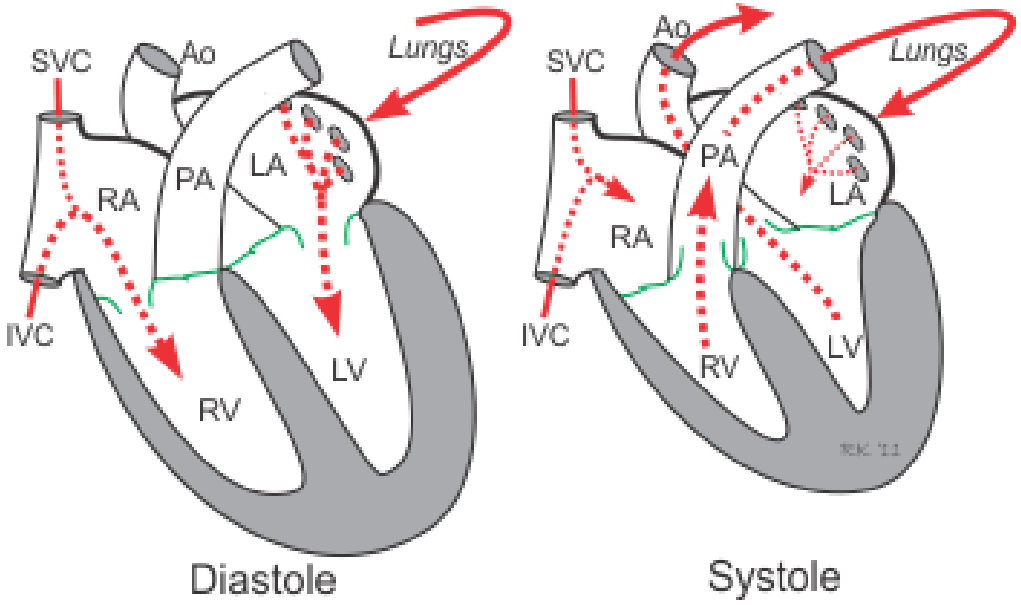
Cardiac Cycle

- Diastole represents the period of time when the ventricles are relaxed.



Cardiac Cycle

- Systole represents the time during which the left and right ventricles contract and eject blood into the aorta and pulmonary artery



Isovolumetric contraction

- First, muscles in the ventricle contract, the pressure of the blood within the chamber rises, but it is not yet high enough to open the semilunar (pulmonary and aortic) valves and be ejected from the heart. However, blood pressure quickly rises above that of the atria that are now relaxed and in diastole. This increase in pressure causes blood to flow back toward the atria, closing the tricuspid and mitral valves. Since blood is not being ejected from the ventricles at this early stage, the volume of blood within the chamber remains constant. Consequently, this initial phase of ventricular systole is known as **isovolumic contraction**, also called isovolumetric contraction.

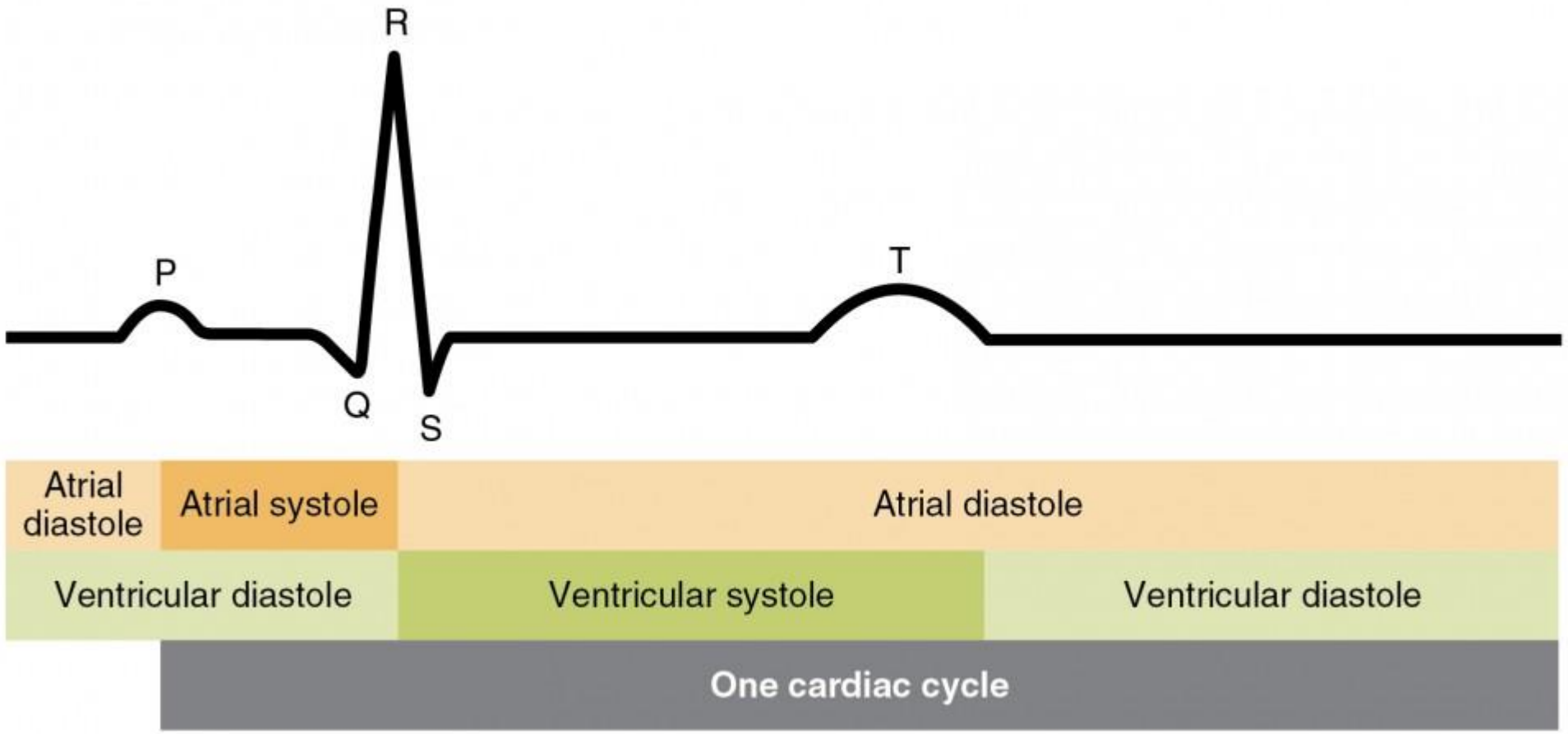
Ventricular Systole

- In the second phase of ventricular systole, the **ventricular ejection phase**, the contraction of the ventricular muscle has raised the pressure within the ventricle to the point that it is greater than the pressures in the pulmonary trunk and the aorta. Blood is pumped from the heart, pushing open the pulmonary and aortic semilunar valves. Pressure generated by the left ventricle will be appreciably greater than the pressure generated by the right ventricle, since the existing pressure in the aorta will be so much higher. Nevertheless, both ventricles pump the same amount of blood. This quantity is referred to as stroke volume. Stroke volume will normally be in the range of 70–80 mL. Since ventricular systole began with an EDV of approximately 130 mL of blood, this means that there is still 50–60 mL of blood remaining in the ventricle following contraction. This volume of blood is known as the **end systolic volume (ESV)**.

Phases of the Cardiac Cycle

- **Ventricular Diastole**
- Ventricular relaxation, or diastole, follows repolarization of the ventricles and is represented by the T wave of the ECG. It too is divided into two distinct phases
- The early phase of ventricular diastole is called the **isovolumic ventricular relaxation phase**, also called isovolumetric ventricular relaxation phase

Phases of the Cardiac Cycle



Mechanism and Contraction Events of Cardiac Muscle Fibers

- **excitation contraction coupling (ECC)**: The physiological process of converting an electrical stimulus to a mechanical response.
- **calcium-induced calcium release (CICR)**: A process whereby calcium can trigger release of further calcium from the muscle sarcoplasmic reticulum

Mechanism and Contraction Events of Cardiac Muscle Fibers

- Cardiomyocytes are capable of coordinated contraction, controlled through the gap junctions of intercalated discs. The gap junctions spread action potentials to support the synchronized contraction of the myocardium. In cardiac, skeletal, and some smooth muscle tissue, contraction occurs through a phenomenon known as excitation contraction coupling (ECC)