

Pressure-Volume Loop (Left Ventricle)

[Medical Prematriculation Program](#) > [Cardiac Physiology](#) > [Cardiac Physiology](#)

The pressure-volume loop plots the changes in pressure and volume of blood during a [complete cardiac cycle](#); in this tutorial, we'll focus on the changes within the left ventricle, specifically.

[Key anatomical structures:](#)

Left atrium, superiorly; Left ventricle, inferiorly. Mitral valve, aka, left atrioventricular valve (aka, bicuspid valve), ensures unidirectional blood flow from the atrium to the ventricle. Aorta delivers blood from the left ventricle to the body; Aortic semilunar valve regulates blood flow from the ventricle to the aorta.

[Cardiac Cycle:](#)

Systole is the period of ventricular contraction. Diastole is the period of ventricular relaxation.

PRESSURE VOLUME LOOP - GRAPH

To illustrate the effects of [preload, contractility, and afterload](#) on stroke volume, we can use a pressure-volume loop. Establish the normal loop: – The x-axis tracks left ventricular volume from 40-120 mL. – The y-axis tracks left ventricular pressure from 0-120 mmHg. We begin with ventricular diastole, when pressure is ~10 mmHg and volume is ~50 mL. Now, show that the mitral valve opens and allows passive ventricular filling; Thus, volume increases, even as pressure continues to fall due to muscle relaxation during diastole. At point B, pressure begins to increase, slightly, due to continued filling. Ultimately, the rise in pressure closes the mitral valve (point C), and diastole is complete; highlight that end-diastolic volume is approximately 120 mL. At this point, isovolumetric contraction raises ventricular pressure; notice that this is isovolumetric contraction because volume remains the same. At point D, when pressure is approximately 80 mmHg; the aortic valve is pushed open and allows blood ejection. Thus, contraction decreases blood volume and raises ventricular pressure to 130 mmHg (Point E). Because of blood ejection, both pressure and blood volume fall to point F, which permits aortic valve closure and marks the end of systole; highlight that end-systolic volume is 50 mL. Isovolumetric relaxation brings left ventricular pressure back to point A. Finally, indicate that the *stroke volume* is equal to the distance between the end systolic volume and end diastolic volume.

Summary by segments:

- AB: marks the period of ventricular relaxation and filling;
- BC: blood volume increases substantially, though pressure rises only slightly.
- CD: the mitral valve closes and isovolumetric contraction increases left ventricular pressure (while volume remains unchanged).
- DE: the aortic valve opens and the contracting ventricle ejects blood into the aorta, which reduces its blood volume.
- EF: Pressure falls, and ejection of blood slows.
- FA: the aortic valve closes, and isovolumetric relaxation reduces pressure while volume remains the same.

Additional information:

[Stroke volume](#) = width of the pressure-volume loop; is the difference between end-diastolic volume and end-systolic volume; In a healthy heart, this is the volume of blood ejected by the left ventricle in a single cardiac cycle. Pressure-volume loops are used to illustrate how changes in preload, afterload, and myocardium contractility (aka, inotropy) effect stroke volume.

FULL-LENGTH TEXT

- Here we will learn about the pressure-volume loop that corresponds to the left ventricle during a single cardiac cycle.

- To begin, start a table, and denote that:

- The pressure-volume loop plots the changes in pressure and volume of blood during a complete cardiac cycle; in this tutorial, we'll focus on the changes within the left ventricle, specifically.

First, let's draw the key anatomical structures so we can understand the path of blood flow during the cardiac cycle.

- Outline the heart in coronal section; label the left atrium, superiorly, and, the left ventricle, inferiorly.
- Show that the mitral valve, aka, left atrioventricular valve (aka, bicuspid valve), ensures unidirectional blood flow from the atrium to the ventricle.
- Draw the aorta, which delivers blood from the left ventricle to the body; the aortic semilunar valve regulates blood flow from the ventricle to the aorta.

Now, in our table, define systole and diastole of the cardiac cycle:

- Systole is the period of ventricular contraction.
- Diastole is the period of ventricular relaxation.

Next, prepare the pressure-volume loop graph:

- The x-axis tracks left ventricular volume from 40-140 ml.
- The y-axis tracks left ventricular pressure from 0-140 mmHg.

Next, let's show the four phases of the cardiac cycle for the left ventricle:

We'll begin at the beginning of ventricular diastole, when pressure is ~10 mmHg and volume is ~ 50 mL.

- Now, show that the mitral valve opens and allows passive ventricular filling; thus, volume increases, even as pressure continues to fall due to muscle relaxation during diastole.

- At point B, pressure begins to increase, slightly, due to continued filling.
- Ultimately, the rise in pressure closes the mitral valve (point C), and diastole is complete; highlight that end-diastolic volume is approximately 120 mL.
- At this point, isovolumetric contraction raises ventricular pressure; notice that this is isovolumetric contraction because blood volume remains the same.
- At point D, when pressure is approximately 80 mmHg; the aortic valve is pushed open and allows blood ejection.
- Thus, contraction decreases blood volume and raises ventricular pressure to 130 mmHg (Point E).
- Because of blood ejection, both pressure and blood volume fall to point F, which permits aortic valve closure and marks the end of systole; highlight that end-systolic volume is 50 mL.
- Isovolumetric relaxation brings left ventricular pressure back to point A.
- Finally, indicate that the stroke volume is equal to the distance between the end systolic volume and end diastolic volume.

Let's summarize our pressure-volume loop by segments:

- Indicate that segment AB marks the period of ventricular relaxation and filling;
- During segment BC, blood volume increases substantially, though pressure rises only slightly.
- From C-D, the mitral valve closes and isovolumetric contraction increases left ventricular pressure (while volume remains unchanged).
- From D-E, the aortic valve opens and the contracting ventricle ejects blood into the aorta, which reduces its blood volume.
- In EF, the ventricle begins to relax, pressure falls, and ejection of blood slows.

- Finally, in F-A, the aortic valve closes, and isovolumetric relaxation reduces pressure while volume remains the same.

- Before we conclude, draw a line through the width of the pressure-volume loop to represent stroke volume, which is the difference between end-diastolic volume and end-systolic volume;

- In a healthy heart, this is the volume of blood ejected by the left ventricle in a single cardiac cycle.

- Denote that the pressure-volume loops are used to illustrate how changes in preload, afterload, and myocardium contractility (aka, inotropy) effect stroke volume.