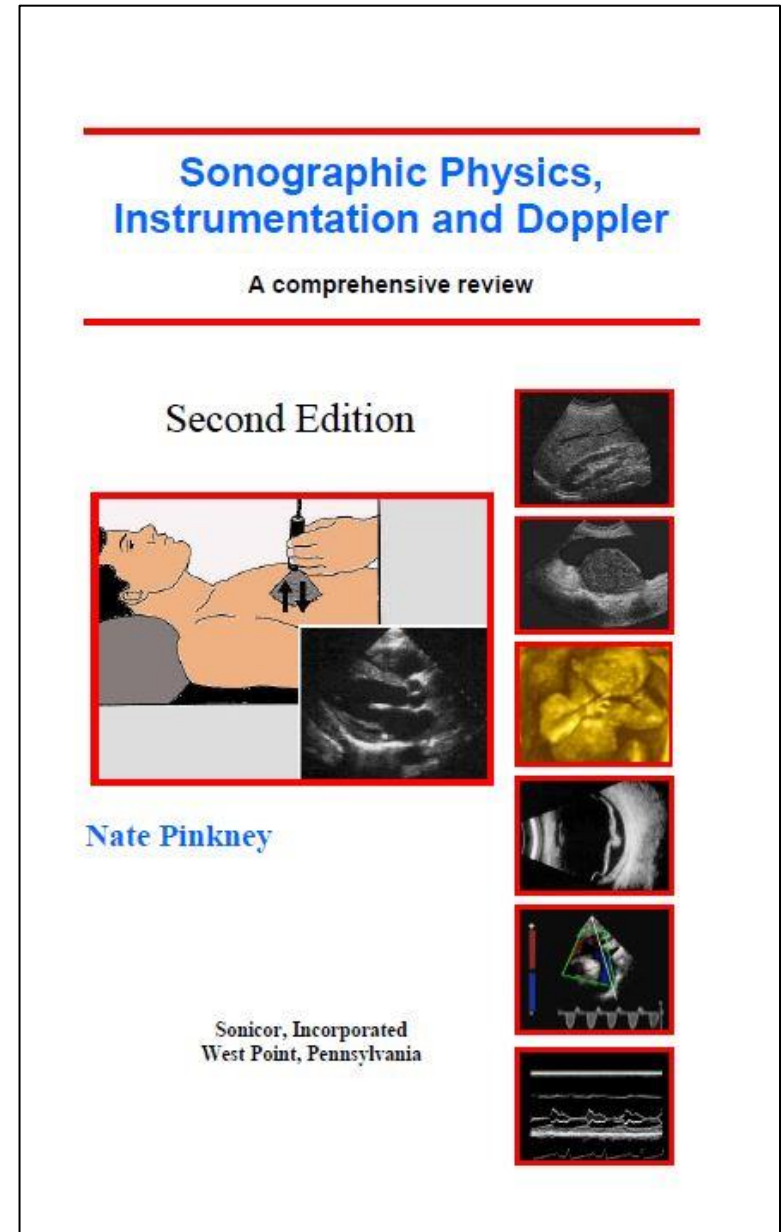


# Lesson 11:

## Circulation and Hemodynamics

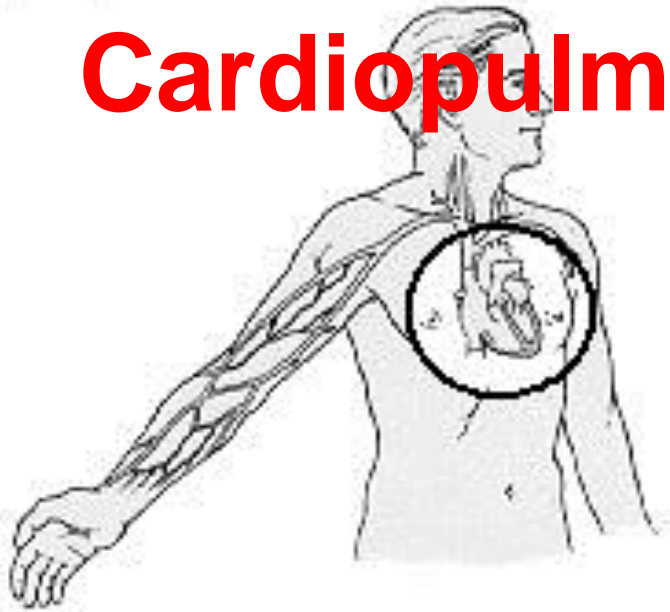
This lesson contains 21 slides plus 2 multiple-choice questions.

Accompanying text for the slides in this lesson can be found on pages 53 through 58 in the textbook:



# MAJOR SYSTEMS OF CARDIOVASCULAR CIRCULATION

**Cardiopulmonary**



**Systemic**



# HEMODYNAMICS

Hemodynamics is the study of the movements of blood and the forces concerned therein.

# **Hemodynamics of Arterial and Venous Circulation**

# ENERGY

**Kinetic energy**

**Potential energy**

**Total fluid energy**

## TOTAL FLUID ENERGY

**Combination of the kinetic energy (blood flow) and the potential energy (blood pressure) present.**

# POISEUILLE'S LAW

## Poiseuille's Law

$$\Delta P = Q \times R$$

$$Q = SV \times HR$$

$$R = \frac{\eta \times L \times 8}{\pi r^4}$$

**Q = flow**

**R = resistance**

**$\eta$  = viscosity**

**L = length**

**r = radius of vessel**

**SV = stroke volume**

**HR = heart rate**

# PRESSURE GRADIENT

$\Delta P$



**FLOW**

**Q**

# RESISTANCE

**R**

# STROKE VOLUME

**SV**

**VISCOCITY**

**VISCOSITY**  
**(Internal friction)**

# VASCULAR RESISTANCE

## RESISTANCE IN THE VASCULAR SYSTEM

<b>Aorta</b>	<b>4%</b>
<b>Large Arteries</b>	<b>5%</b>
<b>Main Branches</b>	<b>10%</b>
<b>Terminal branches</b>	<b>6%</b>
<b>Arterioles</b>	<b>41%</b>
<b>Capillaries</b>	<b>27%</b>
<b>Total venous</b>	<b>7%</b>

# FLOW PATTERNS

- **plug**
- **laminar (parabolic)**
- **disturbed**
- **turbulent**

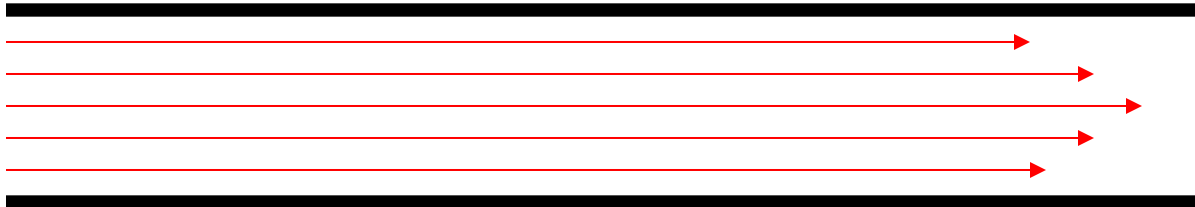
# PLUG FLOW

- **occurs during systole in large vessels**



# LAMINAR FLOW

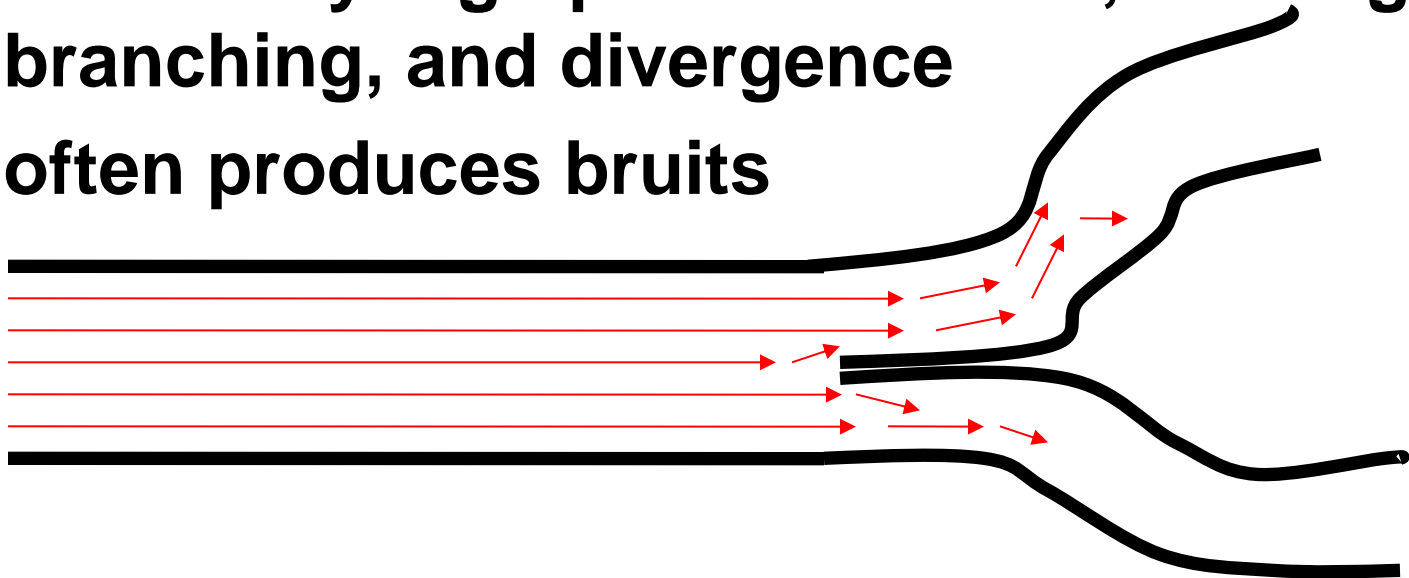
- **thought to exist in the majority of vessels**





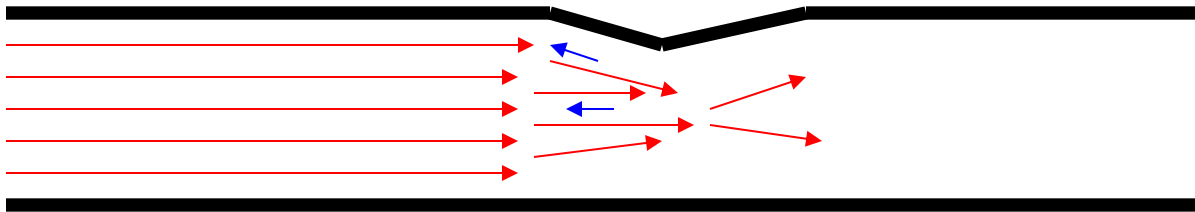
# DISTURBED FLOW

- **caused by high peak velocities, curving, branching, and divergence**
- **often produces bruits**



# TURBULENT FLOW

- often at the location of a stenosis
- significant pressure gradients are present



# BERNOULLI EFFECT

The *Bernoulli Effect* describes the relationship between changes in fluid flow and changes in pressure energy.

$$Q = V \times A$$

(flow = velocity x area)

## **BERNOULLI EFFECT**

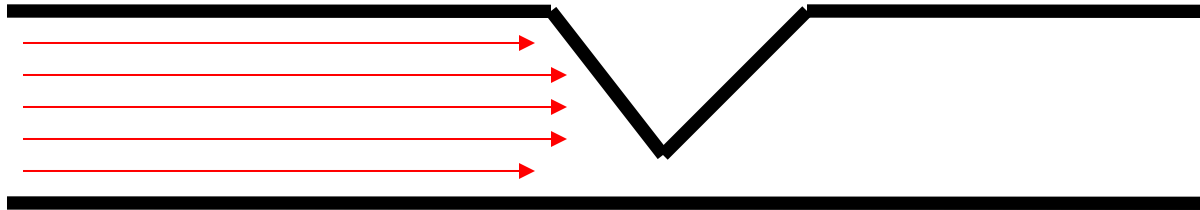
**A reduction in pressure  
accompanies an increase  
in the velocity of fluid  
flow.**

## CRITICAL STENOSIS

- **causes a significant reduction in the amount of blood flow distal to the location of the stenosis**

# CRITICAL STENOSIS

**abdominal aorta  $\Rightarrow$  90% area reduction**

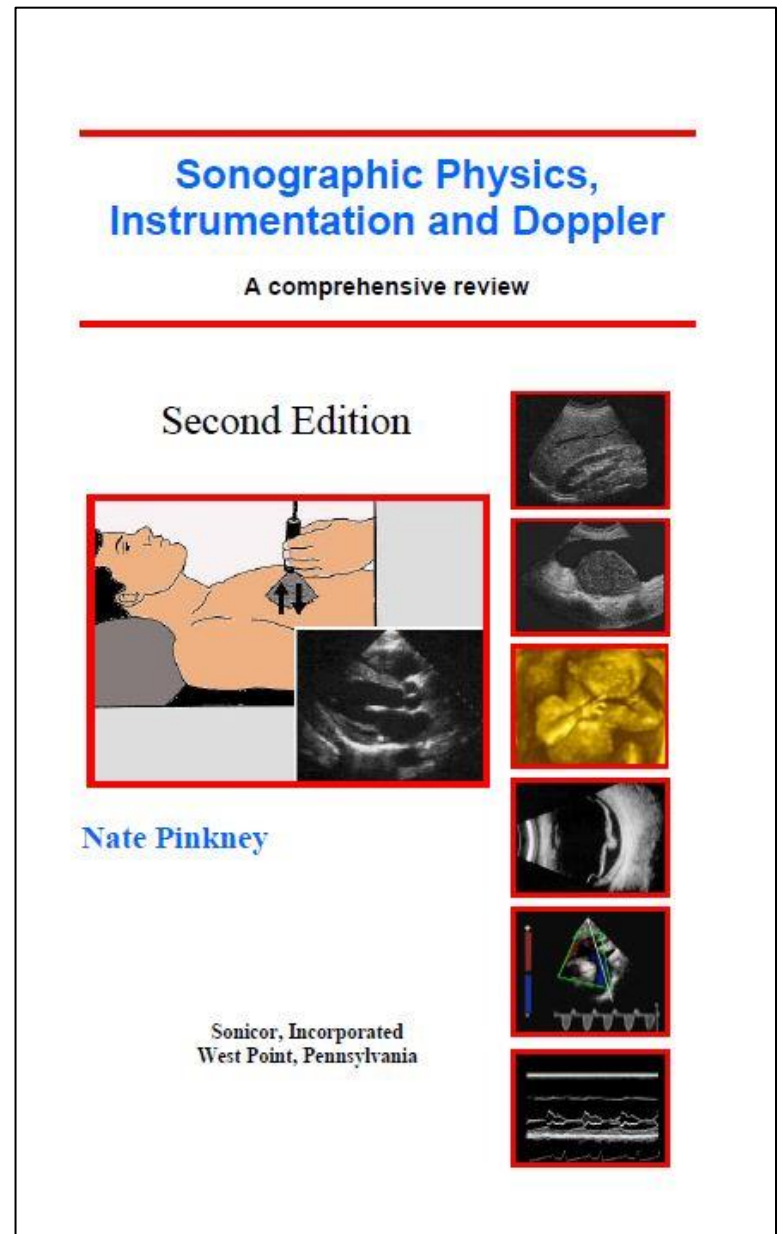


**carotid artery  $\Rightarrow$  75% area reduction**



In the abdominal aorta, a 90% reduction (10% remaining) in area is required before the stenosis is critical, while in the carotid artery a 75% reduction (25% remaining) in area is characterized as critical. A 75% area reduction is equivalent to a 50% diameter reduction, often called a 50% stenosis.

Answers to the following **TWO** practice questions were derived from material in the textbook:



# Question 1

What are the two major systems of cardiovascular circulation?

- pulmonary and circulatory
- cardiopulmonary and pulmonic
- systemic and diastolic
- cardiopulmonary and systemic



## Question 1

What are the two major systems of cardiovascular circulation?

- pulmonary and circulatory
- cardiopulmonary and pulmonic
- systemic and diastolic
- cardiopulmonary and systemic

## Question 2

What is the most important determinant of changes in a vessel's resistance?

- elasticity
- radius
- viscosity
- length

## Question 2

What is the most important determinant of changes in a vessel's resistance?

- elasticity
- radius
- viscosity
- length

## **END OF LESSON 11**

For information on the accompanying textbook, visit the  
Website:

[www.Sonicorinc.com](http://www.Sonicorinc.com)