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 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
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
STROKE VOLUME

SV
VISCOSITY

(Internal friction)
<table>
<thead>
<tr>
<th>VASCULAR SYSTEM</th>
<th>RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta</td>
<td>4%</td>
</tr>
<tr>
<td>Large Arteries</td>
<td>5%</td>
</tr>
<tr>
<td>Main Branches</td>
<td>10%</td>
</tr>
<tr>
<td>Terminal branches</td>
<td>6%</td>
</tr>
<tr>
<td>Arterioles</td>
<td>41%</td>
</tr>
<tr>
<td>Capillaries</td>
<td>27%</td>
</tr>
<tr>
<td>Total venous</td>
<td>7%</td>
</tr>
</tbody>
</table>
FLOW PATTERNS

- plug
- laminar (parabolic)
- disturbed
- turbulent
• 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
• 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 \times area)*
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
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:
What are the two major systems of cardiovascular circulation?

- pulmonary and circulatory
- cardiopulmonary and pulmonic
- systemic and diastolic
- cardiopulmonary and systemic
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- 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
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- viscosity
- length
END OF LESSON 11

For information on the accompanying textbook, visit the Website:

www.Sonicorinc.com