

Artificial heart valves

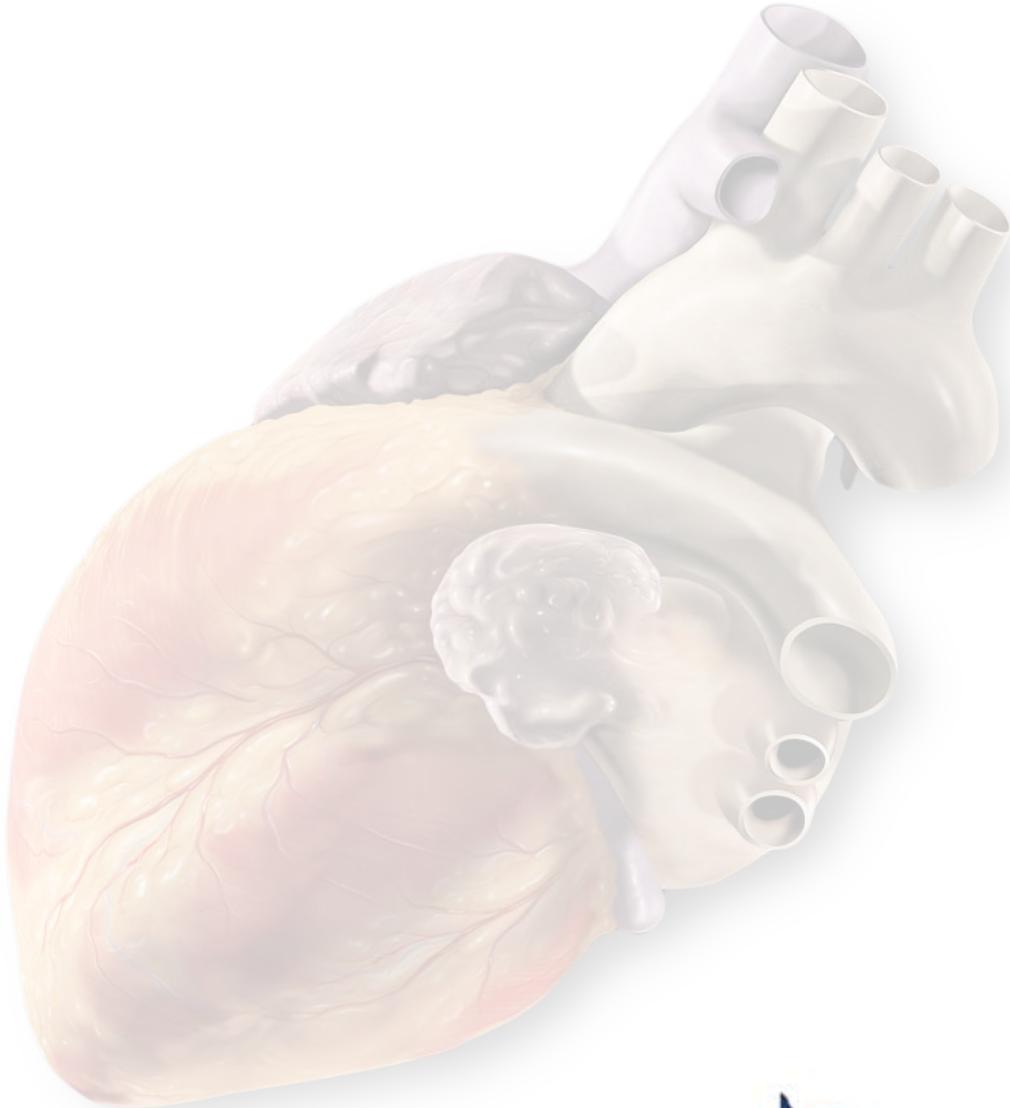
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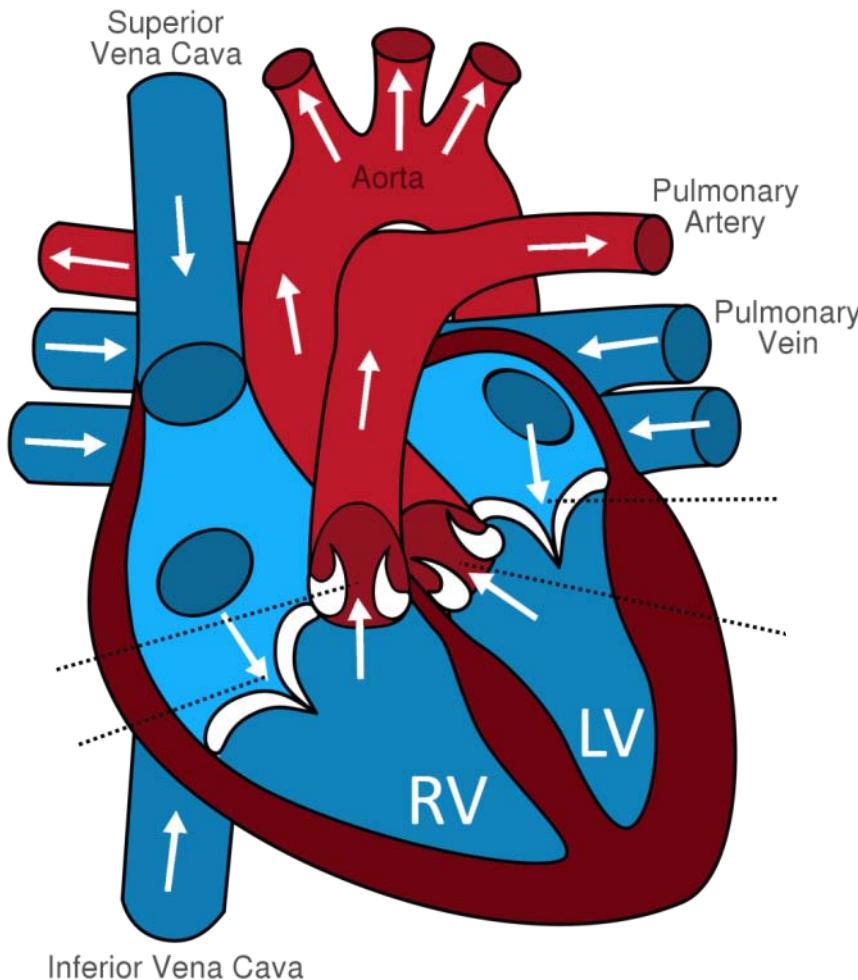
March 29, 2011

Overview

- Introduction
- Classification
- History
- Fabrication
- Problems
- Comparison
- Conclusion



Introduction



There are four valves in the human heart for guiding the blood flow.

- 2 atrioventricular valves
- 2 semilunar valves

Introduction

Indications for heart valve repair/replacement:

- Congenital deformation
- Valve stenosis
- Valve insufficiency/regurgitation

~ 95,000 heart valve surgeries/year worldwide

Classification

Mechanical Heart Valves (MHV)	Biological Heart Valves (BHV)		

History

First successful operation of a mitral valve stenosis

1923

History

First successful implant of an artificial heart-valve (MHV)

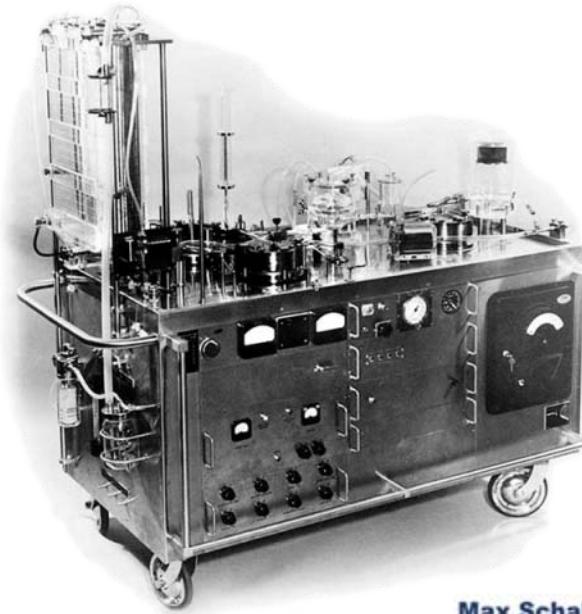
1952



History

First successful open heart operation using a heart-lung-machine

1953



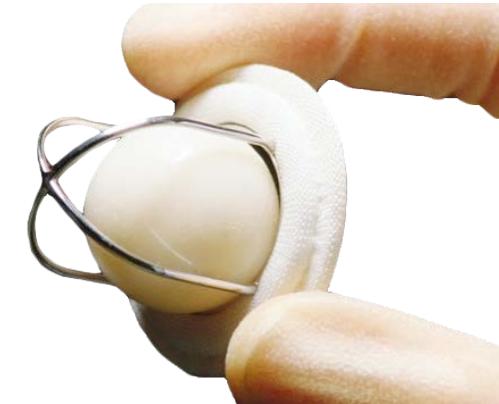
Max Schaldach -
Stiftungsprofessur

Biomedizinische
Technik MSBT

History

Starr-Edwards caged-ball valve (MHV)

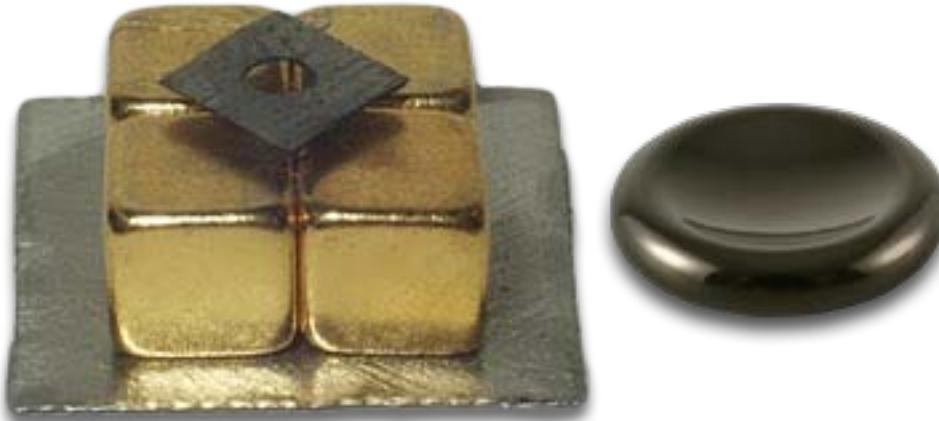
1960



History

Discovery of pyrolytic carbon

1963



History

First pulmonary allograft transplant (BHV)

1967

History

First pyrolytic carbon valve (MHV)

1968



History

Bjork-Shiley tilting-disk valve (MHV)

1969



History

St. Jude Medical bileaflet valve (MHV)

1979



History

First pericardial valve (BHV)

1981



History

First stentless pericardial valve (BHV)

1991

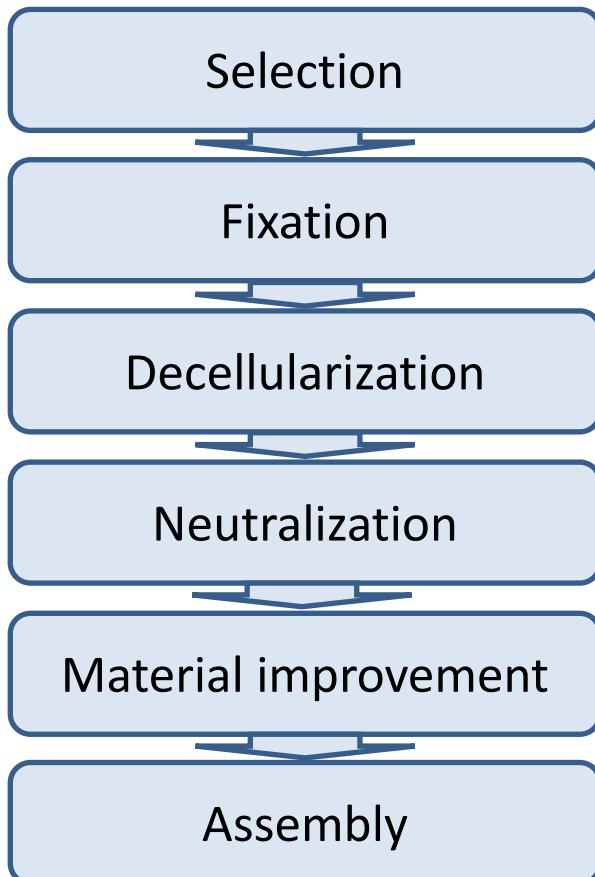


History

First percutaneous valve replacement (BHV)

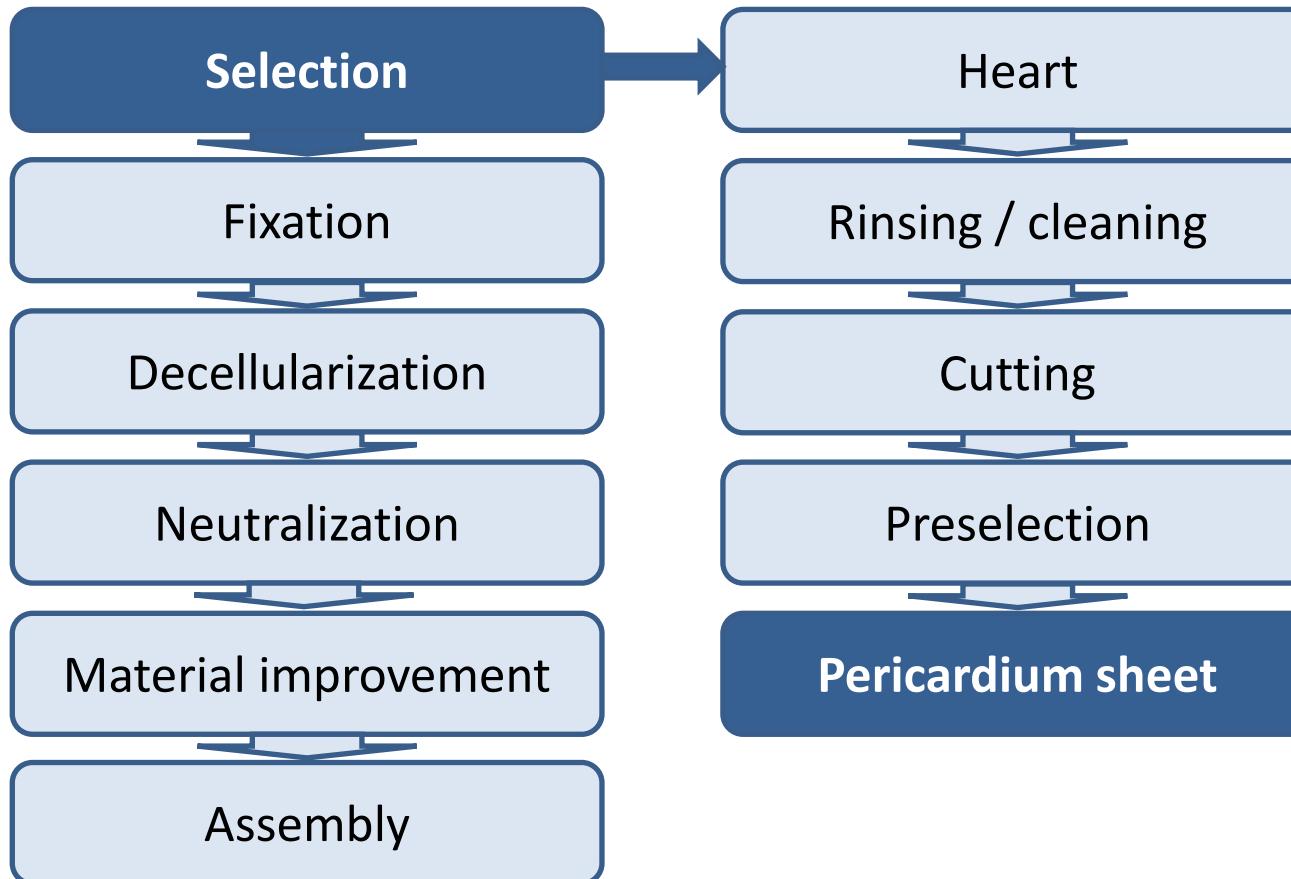


Fabrication

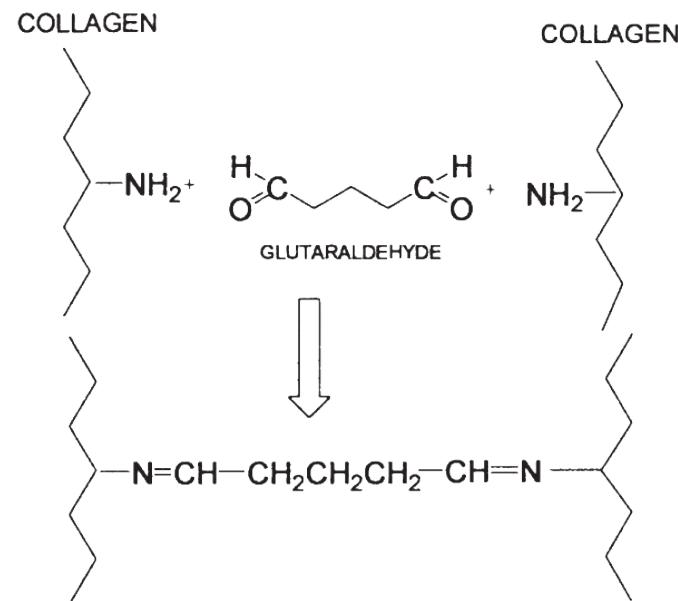
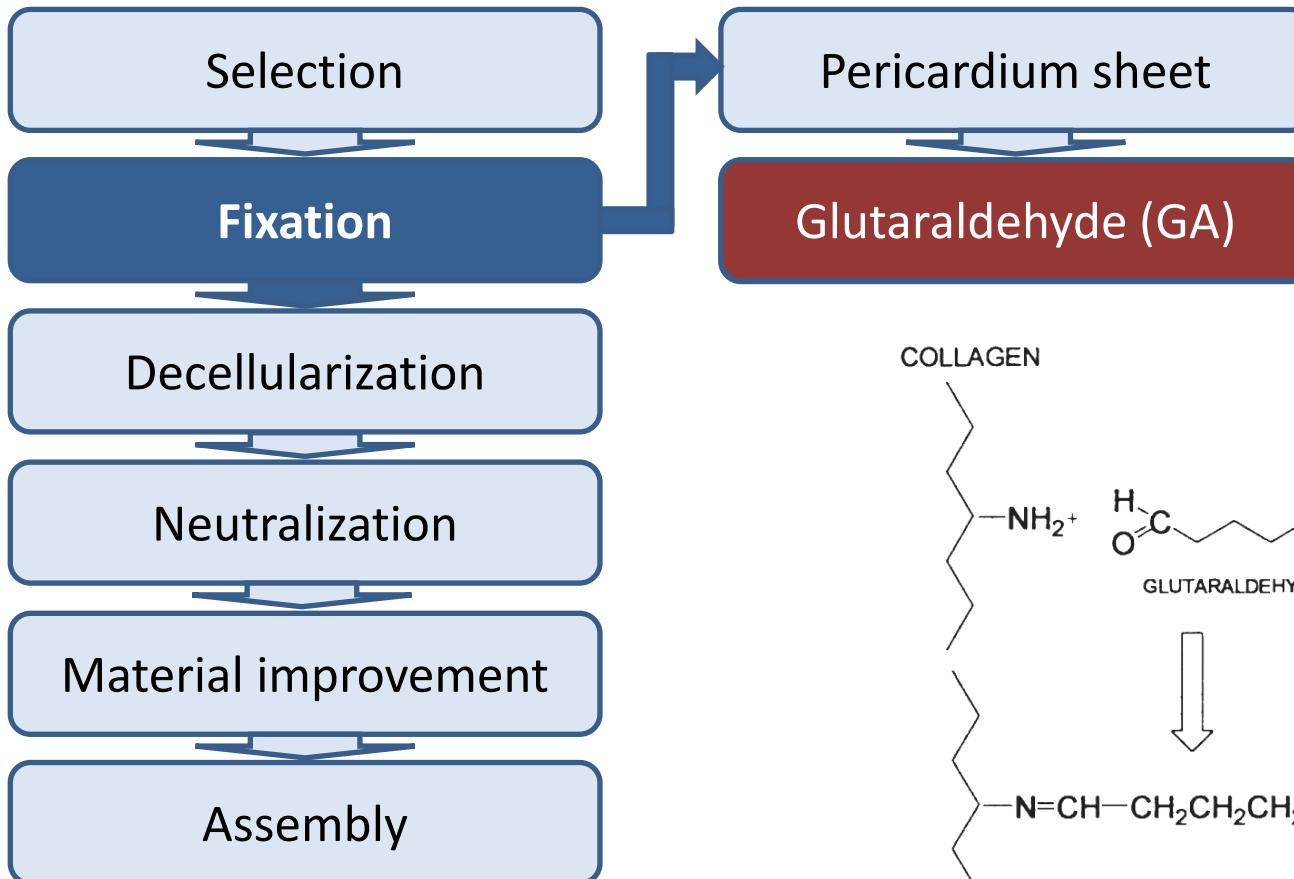


- No standard procedure
- Difficult biological processes
- No in-vitro testing

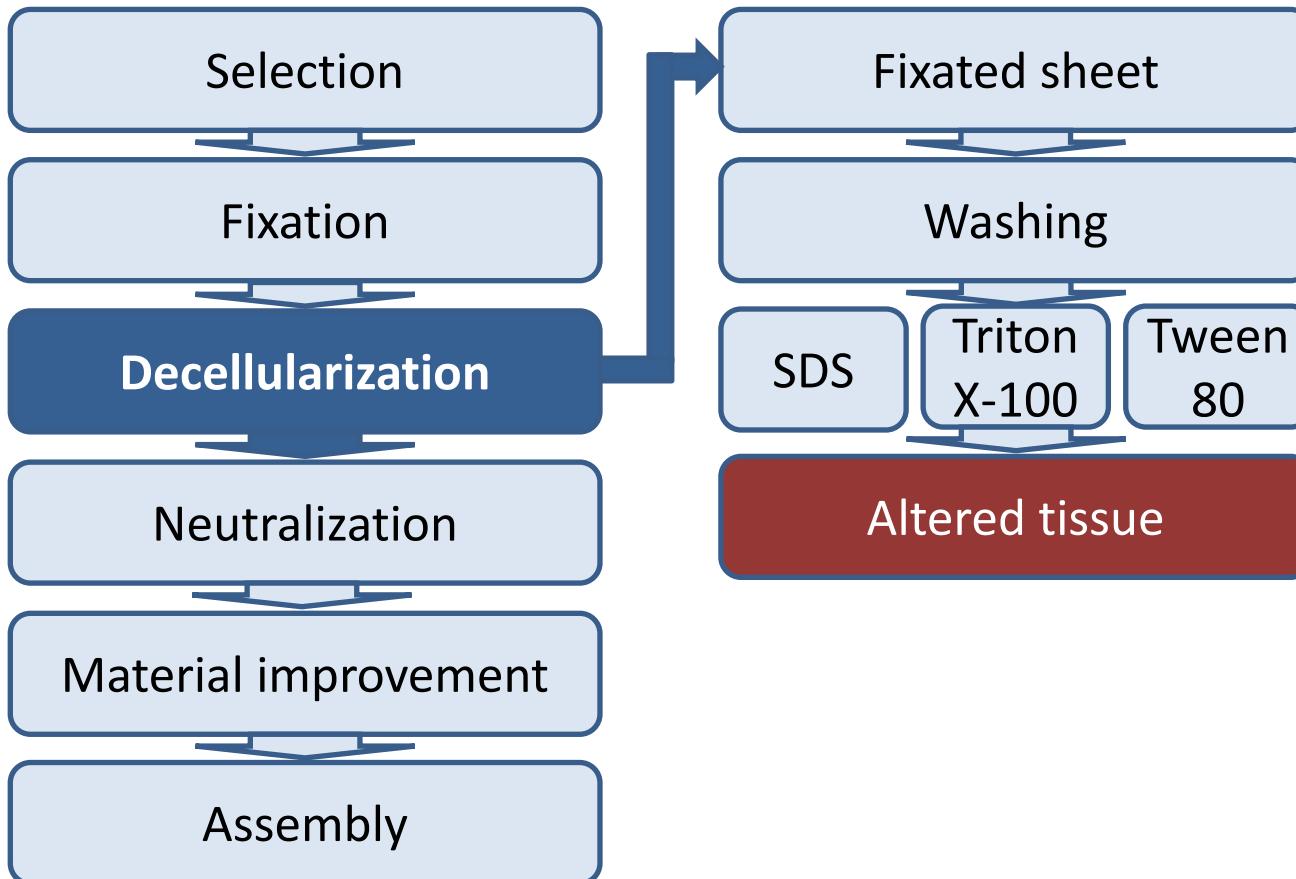
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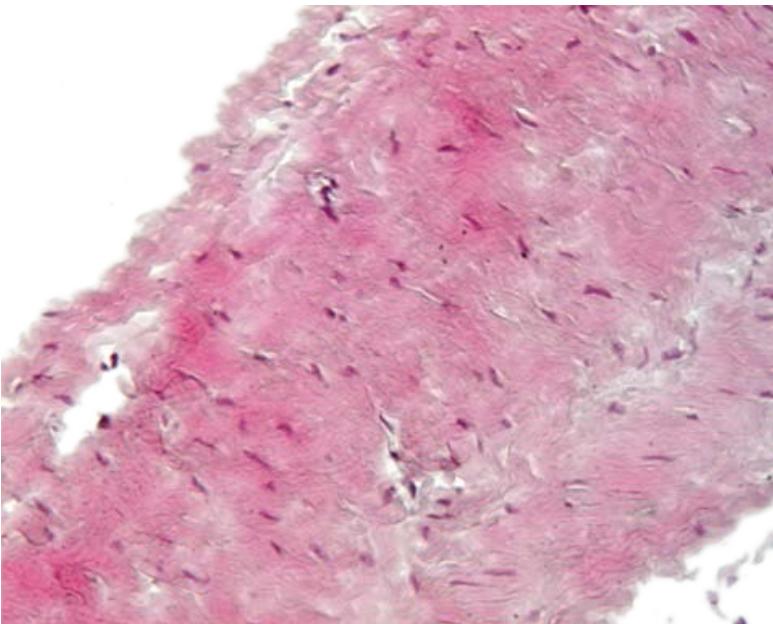
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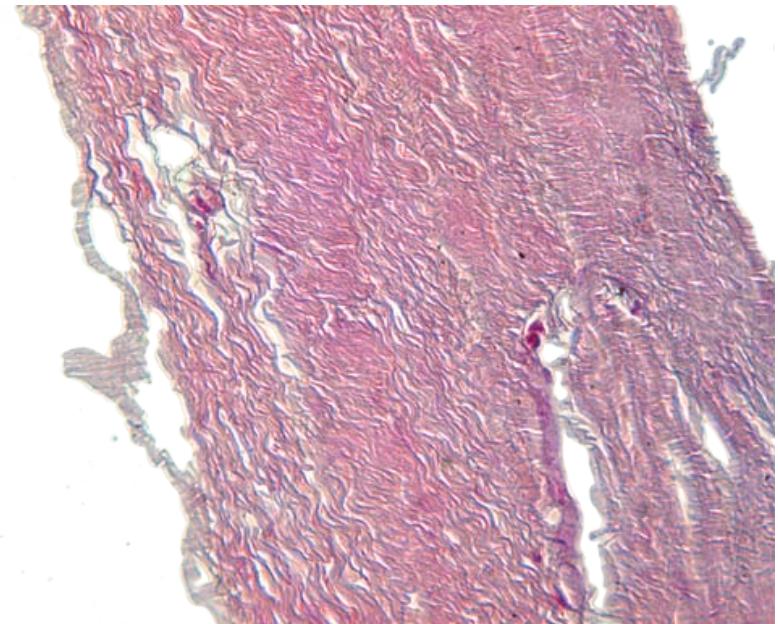
Fabrication



Fabrication: decellularization

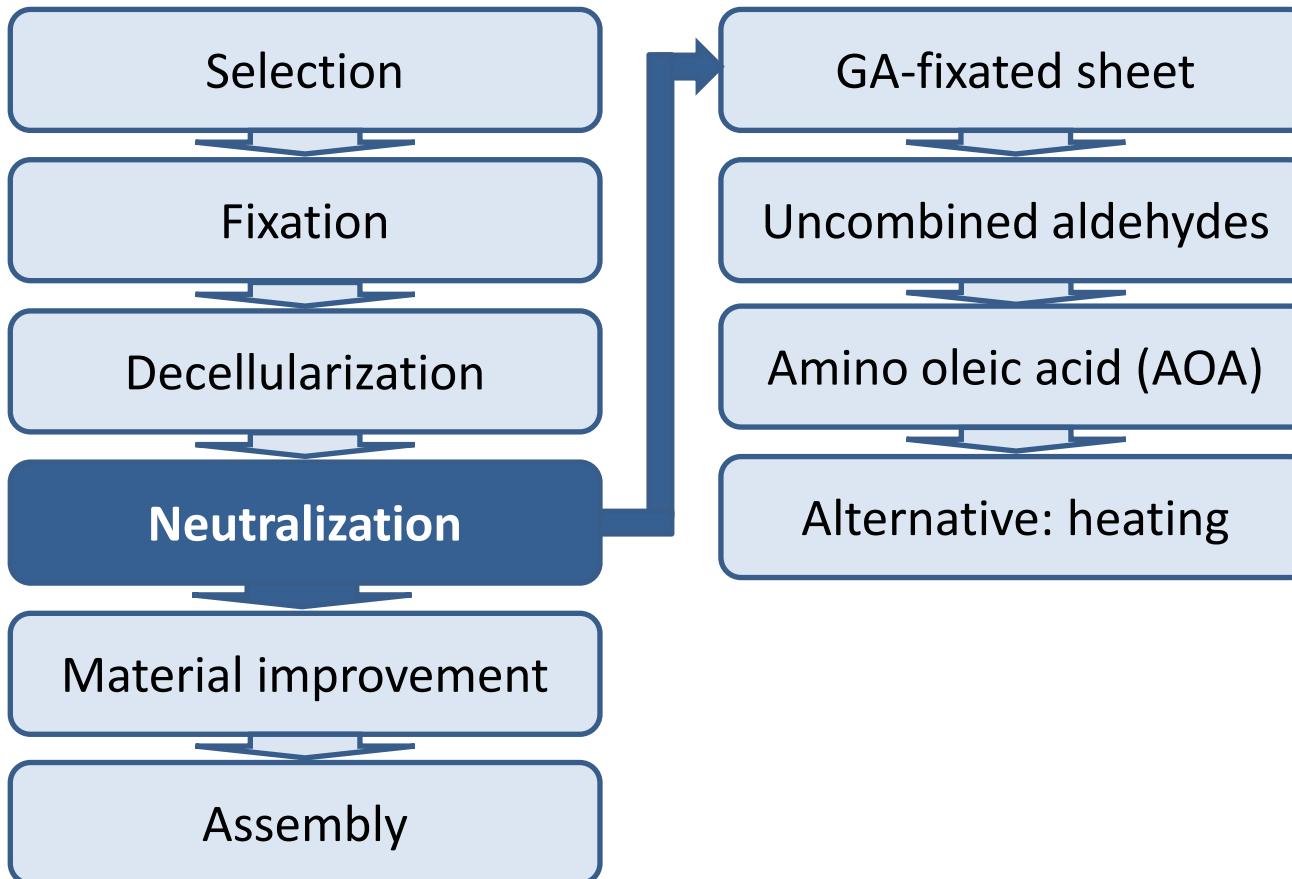


Native porcine pericardium with hematoxylin and eosin stain (mag. 300x)

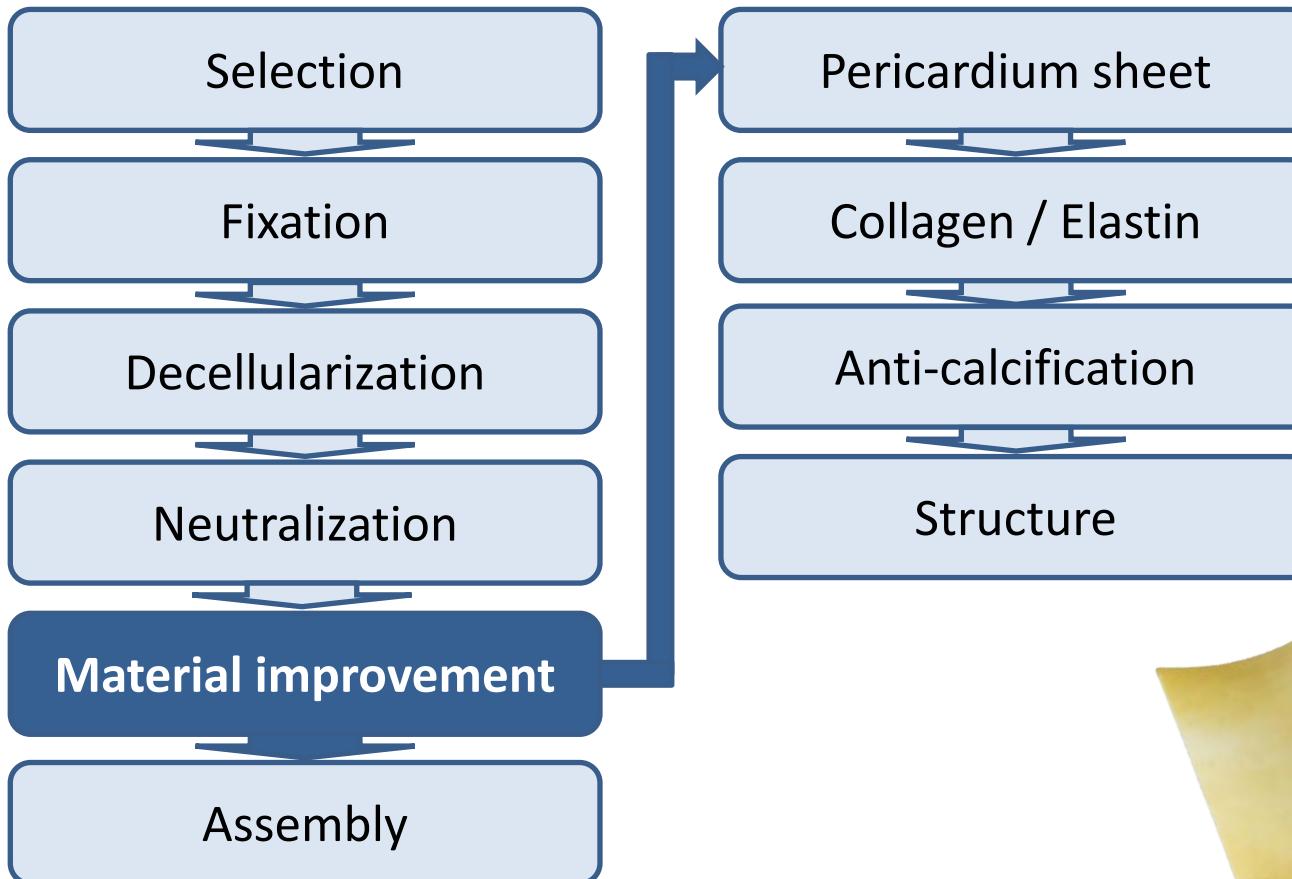


Bovine pericardium with hematoxylin and eosin stain (mag. 300x)

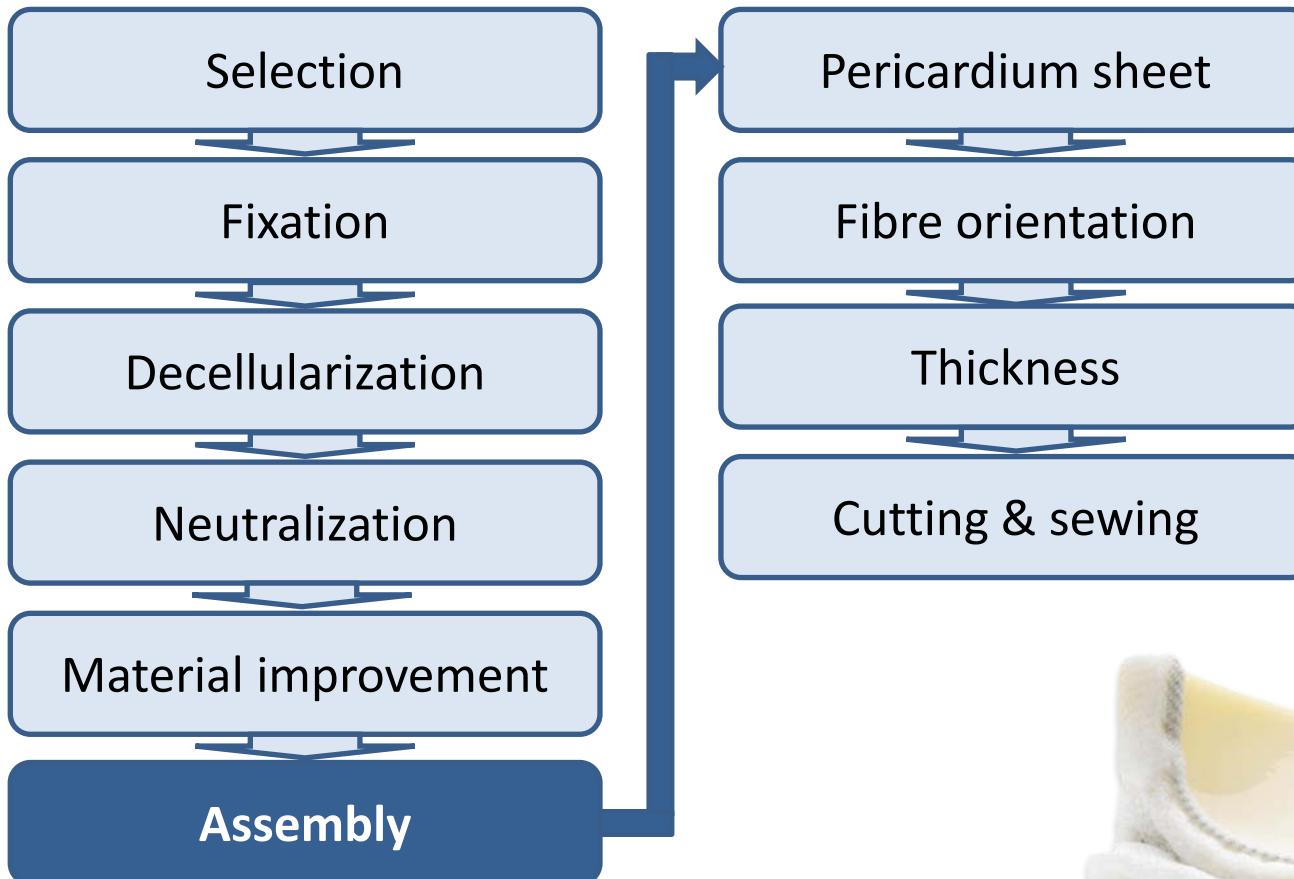
Fabrication



Fabrication



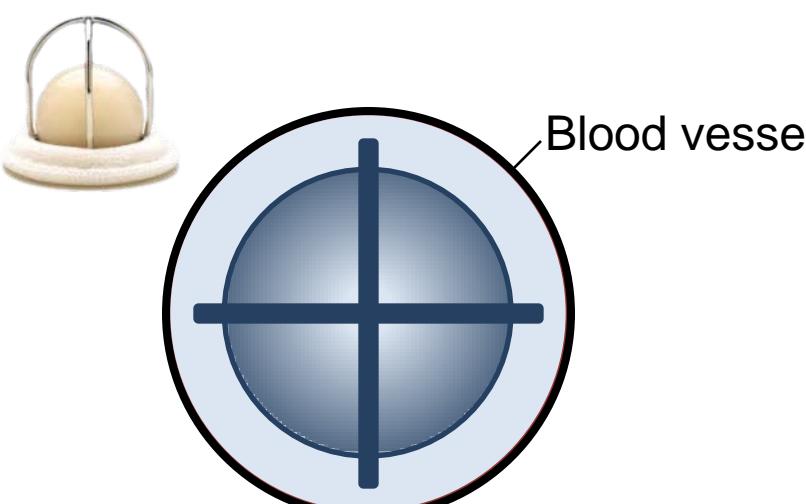
Fabrication



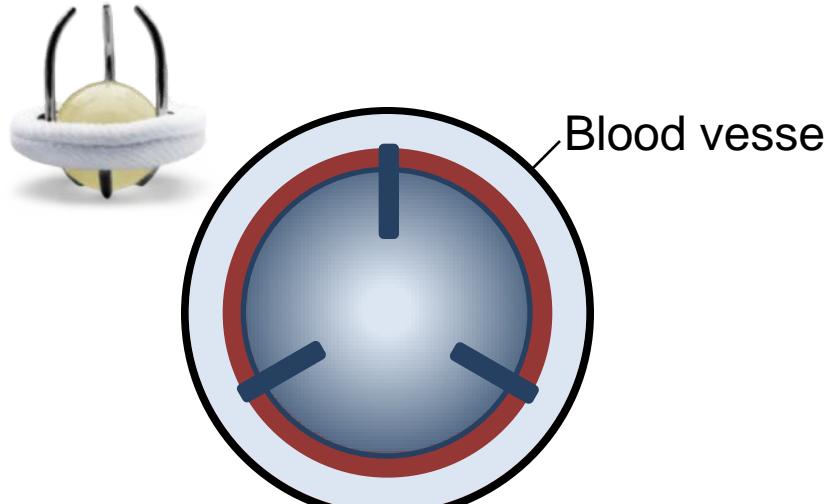
Problems

Mechanical heart valves	Biological heart valves

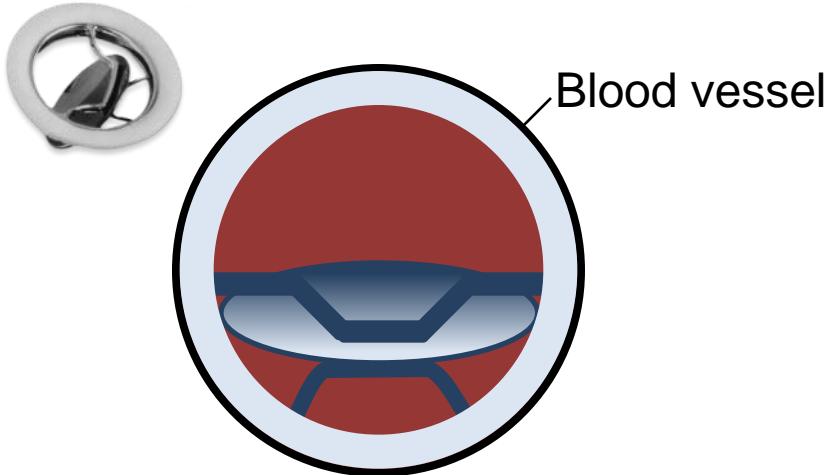
Problems

Mechanical heart valves	Biological heart valves
<ul style="list-style-type: none">■ Coagulation■ Cell damage■ Tissue irritation  <p>Caged-ball valve</p>	

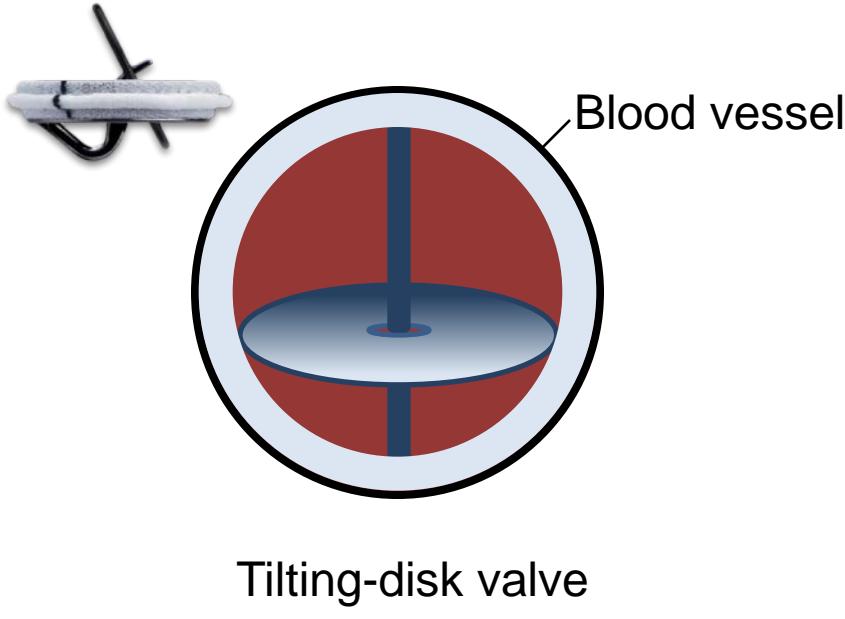
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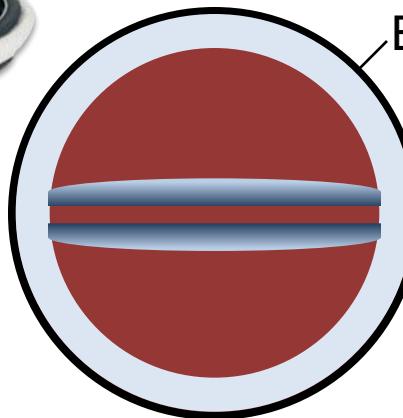
Problems

Mechanical heart valves	Biological heart valves
<ul style="list-style-type: none">■ Coagulation■ Cell damage■ Tissue irritation  <p>The diagram illustrates a mechanical heart valve. On the left, a small image shows a metallic valve component. The main illustration is a circular cross-section of a blood vessel. Inside, a blue, semi-circular tilting-disk valve is shown in its open position, allowing blood to flow. The interior of the vessel is shaded red.</p> <p>Blood vessel</p> <p>Tilting-disk valve</p>	

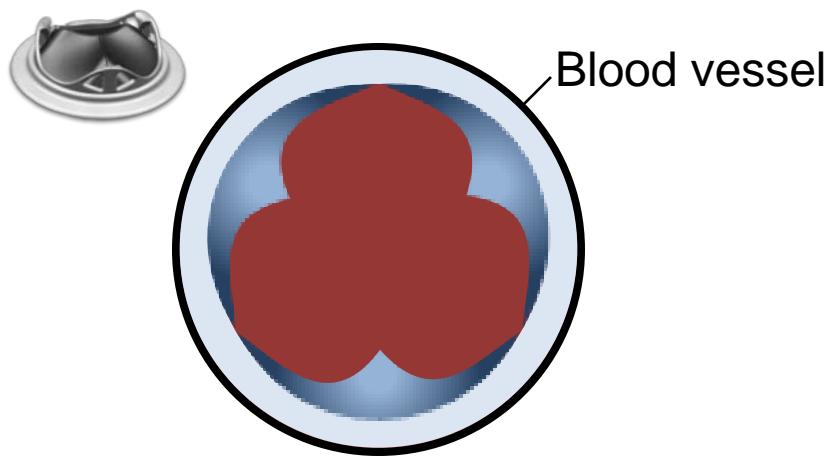
Problems

Mechanical heart valves	Biological heart valves
<ul style="list-style-type: none">■ Coagulation■ Cell damage■ Tissue irritation  <p>The diagram illustrates a mechanical heart valve, specifically a tilting-disk valve. It shows a cross-section of a blood vessel with a blue tilting disk valve. The valve is held in place by two metal leaflets. The text 'Blood vessel' points to the outer circular boundary, and 'Tilting-disk valve' points to the central valve mechanism.</p>	

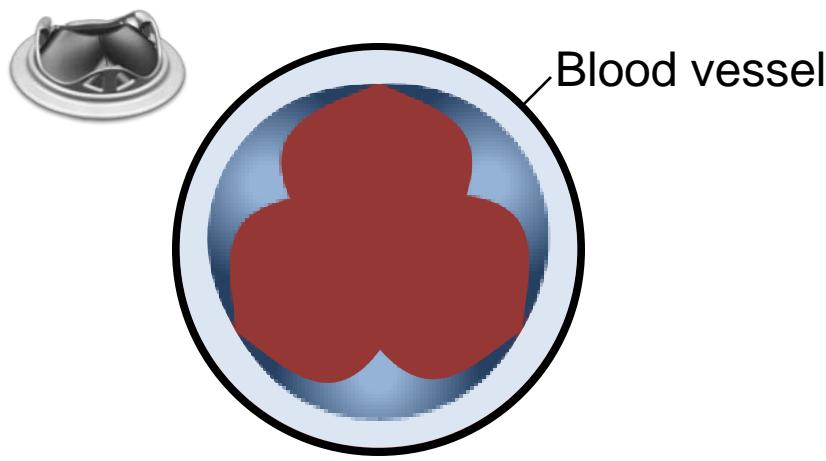
Problems

Mechanical heart valves	Biological heart valves
<ul style="list-style-type: none">■ Coagulation■ Cell damage■ Tissue irritation  <p>Bileaflet valve</p>	

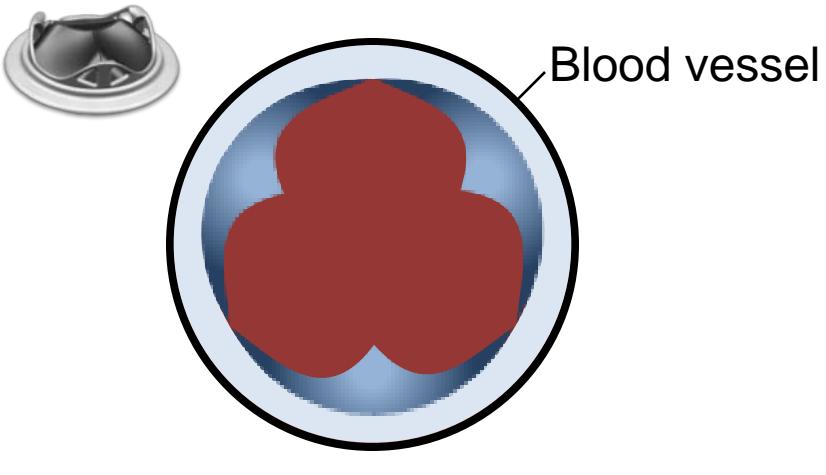
Problems

Mechanical heart valves	Biological heart valves
<ul style="list-style-type: none">■ Coagulation■ Cell damage■ Tissue irritation  <p>The diagram illustrates a mechanical heart valve. On the left, a small metallic valve component is shown. To its right, a larger circular cross-section of a blood vessel is depicted. Inside the vessel, a trileaflet valve is shown, consisting of three red, leaf-like flaps. A label 'Blood vessel' points to the outer circular boundary, and a label 'Trileaflet valve' points to the internal valve structure.</p>	

Problems

Mechanical heart valves	Biological heart valves
<ul style="list-style-type: none">■ Coagulation■ Cell damage■ Tissue irritation  <p>The diagram illustrates a mechanical heart valve. On the left, a small metallic valve component is shown. To its right, a larger circular cross-section of a blood vessel is depicted, containing a trileaflet valve. The valve consists of three red, heart-shaped leaflets. A label 'Blood vessel' points to the surrounding tissue, and a label 'Trileaflet valve' points to the internal valve structure.</p>	<ul style="list-style-type: none">■ Calcification  <p>A photograph of a biological heart valve that has undergone significant calcification. The valve leaflets appear thickened and discolored, with large, yellowish-brown calcific deposits covering much of the interior surface. The surrounding tissue shows signs of degeneration and fibrosis.</p>

Problems

Mechanical heart valves	Biological heart valves
<ul style="list-style-type: none">■ Coagulation■ Cell damage■ Tissue irritation  <p>Trileaflet valve</p> <p>Blood vessel</p>	<ul style="list-style-type: none">■ Calcification <div data-bbox="1032 400 1762 554"><p>Anti-calcification treatment</p></div> <div data-bbox="1032 597 1762 751"><p>Calcified leaflets removal</p></div> <div data-bbox="1032 885 1762 1048"><p>Percutaneous implantation</p></div>

Comparison

	Mechanical heart valves	Biological heart valves
Advantages		
Disadvantages		

Conclusion

Future topics:

- Increasing long-term stability of biological valves
- Understanding calcification processes
- Focus on percutaneous implantation

Biological heart valves will replace mechanical valves eventually.



Thank you for your attention!