MEDIZINISCHE UNIVERSITÄT WIEN

Bioartificial Surfaces

Blood – surface interaction

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Blood contact

- Vascular prosthesis
- Circulatory assist devices
- Heart lung machine: ECMO
- Artificial heart valves
- Stents
- Dialysis

Coagulation Cascade

Endothelium

Contact of blood with non-biological surfaces

- Thrombosis
- Embolism
- Thrombocytepenia (bleeding)
- Pannus formation
- Infection

Vascular prothesis

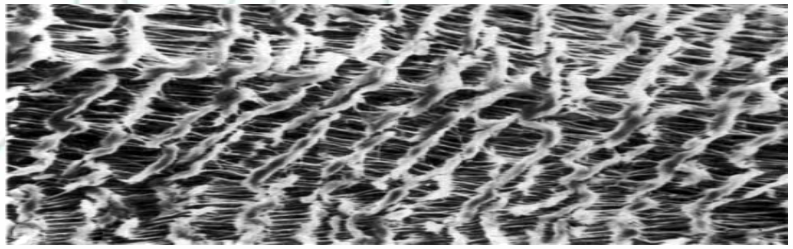
- Porous
- Smooth
- Tissue engineered
- Electro-spinning

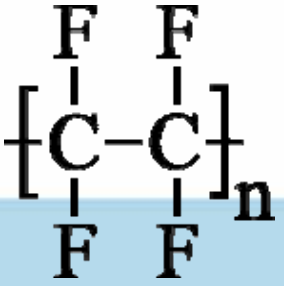
PTFE

(Polytetrafluorethylen; Gore-Tex®)

- Polymer
  - High Cristallinity
- Inert and rather hydrophob
- Application of PTFE:
  - Vascular prosthesis, suture material

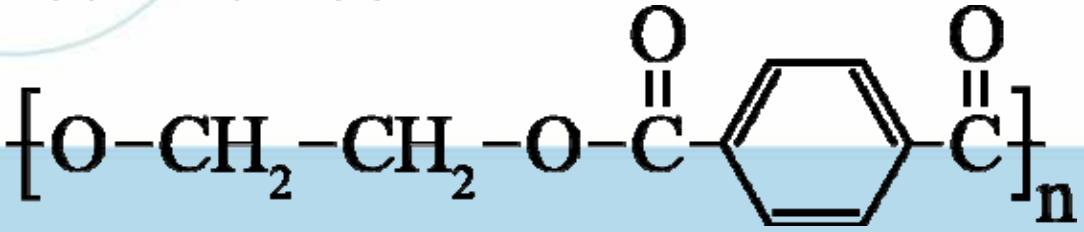
www.goremedical.com



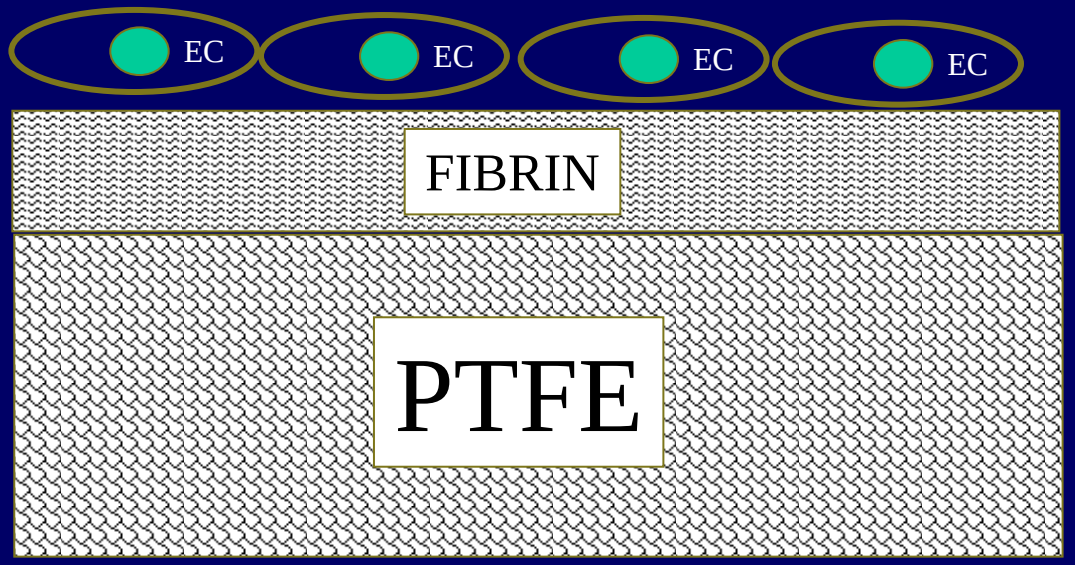


PET (Dacron®)

- Partly cristalline Polymer
- Hydrophob
- Porous
- Enzymatically disolvable
- Application:
  - Vascular prosthesis (Dacron)
  - Suture ring in heart valves



In vitro endothelialization is a classical tissue engineering approach

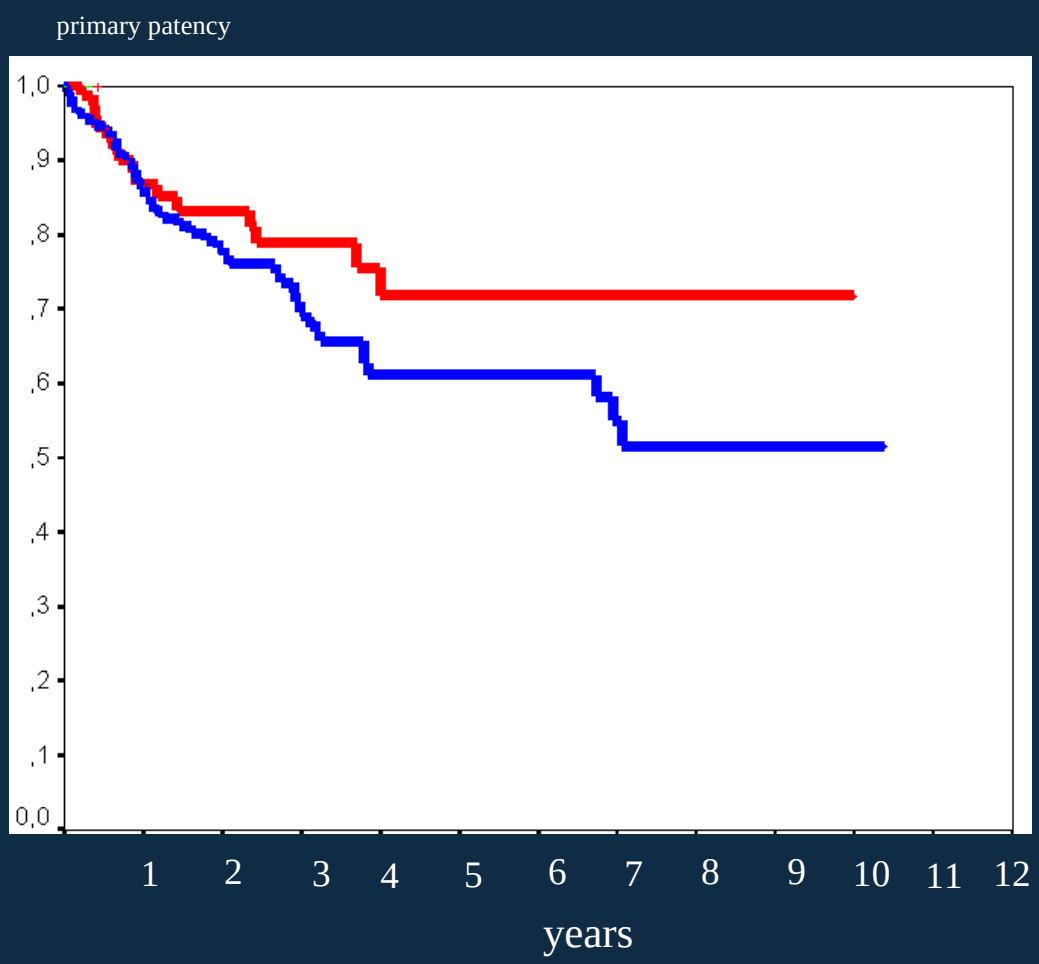


Primary Patency of Endothelialized Grafts Above Knee / Below Knee

	years	3	5	7
	Ak=157	70	61	55
	Bk=101	79	72	72

Log rank=0.35

Breslow=0.51



Ludwig Boltzmann Cluster
kardiovaskuläre Forschung

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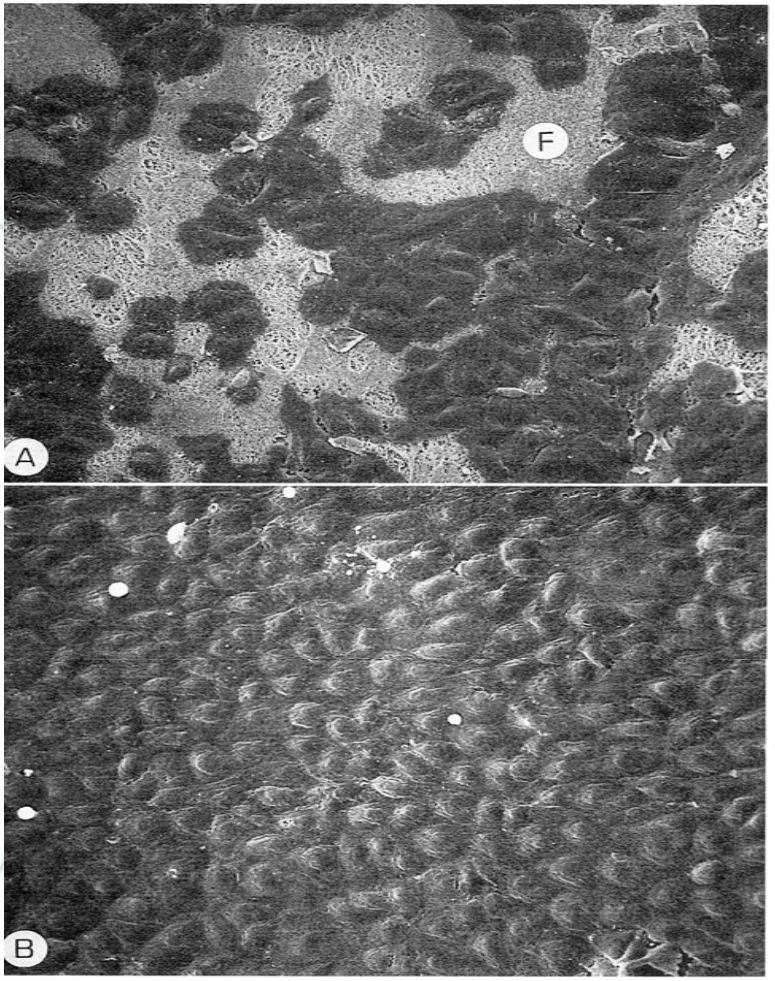
Immediately after seeding

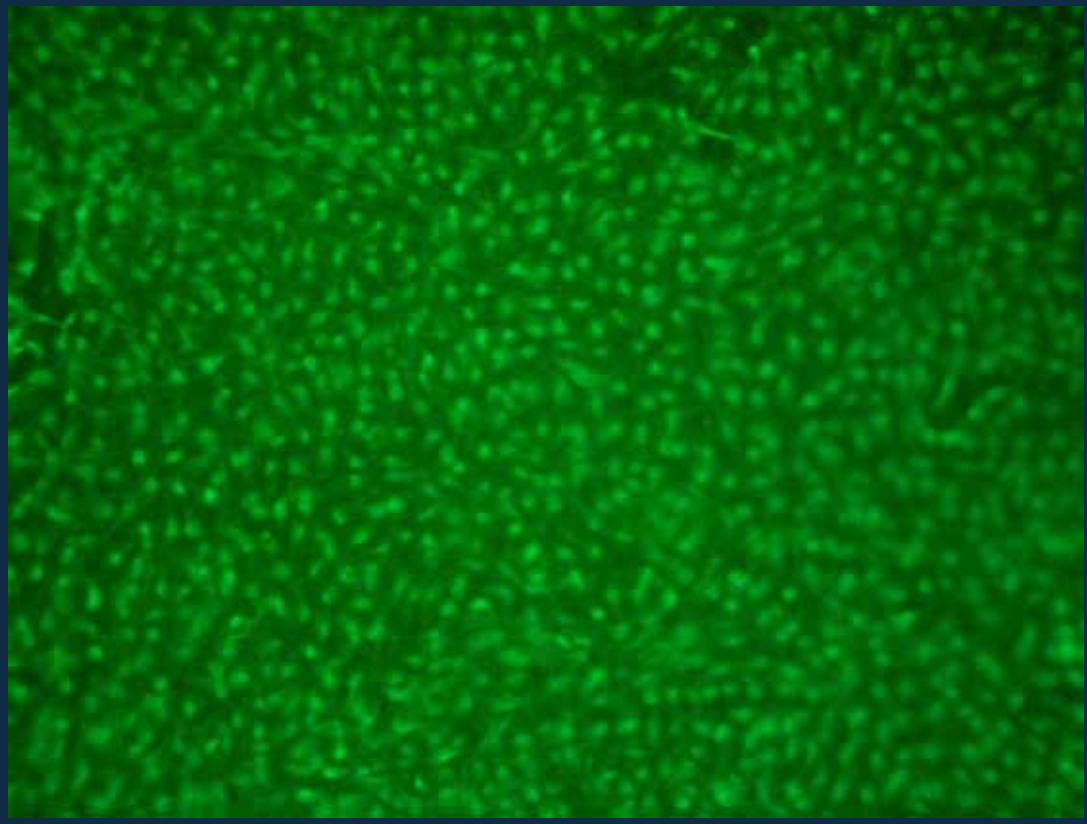
After 3 weeks of cultivation



Quality Control

the success of the seeding procedure is checked with the life/dead fluoresence kit

before implantation



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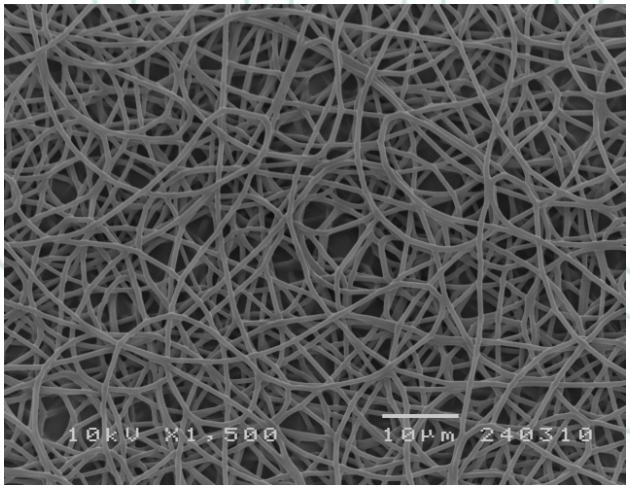
Vascular prostheses with electro-spinning

Electrospinning: polymer fibers produced through high voltage in nano-/ micrometer dimension

Spinned PU Graft, Ø 2mm



Fiber nets from natural and synthetic solulable polymer

Mechanical Circulatory Support
Types of Pumps

Pulsatile Pumps

Volume-displacement pumps

↓

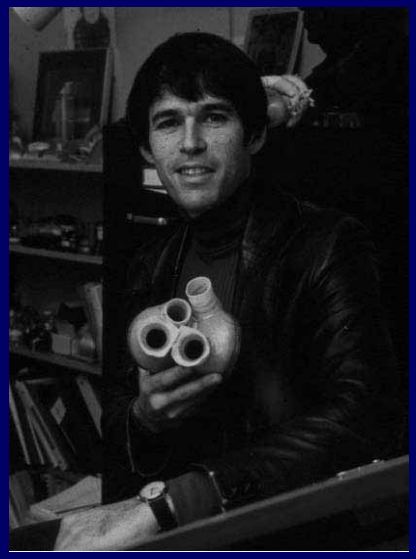
Pulsatile blood flow

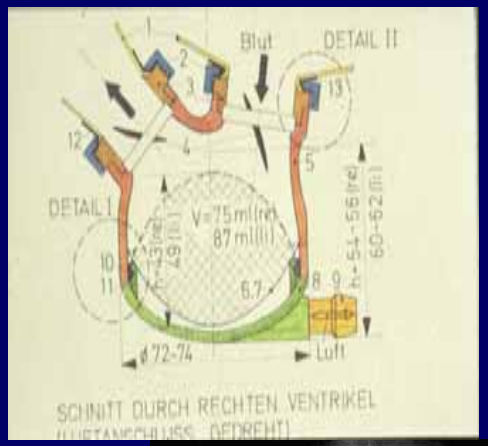
Non-pulsatile Pumps
Rotary Blood Pumps

Axial pumps
Centrifugal pumps

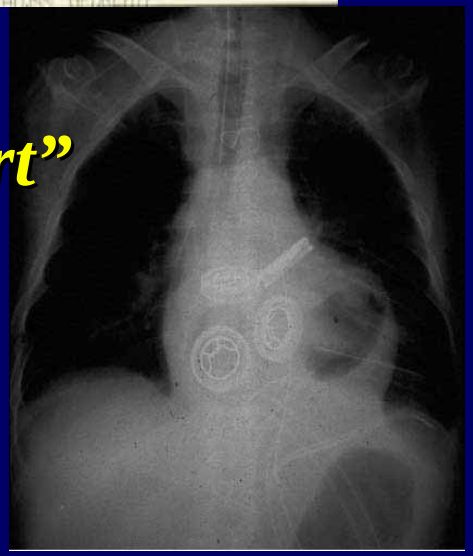
↓

Non-pulsatile, continuous blood flow





"The Total Artificial Heart"



Ludwig Boltzmann Cluster
kardiovaskuläre Forschung

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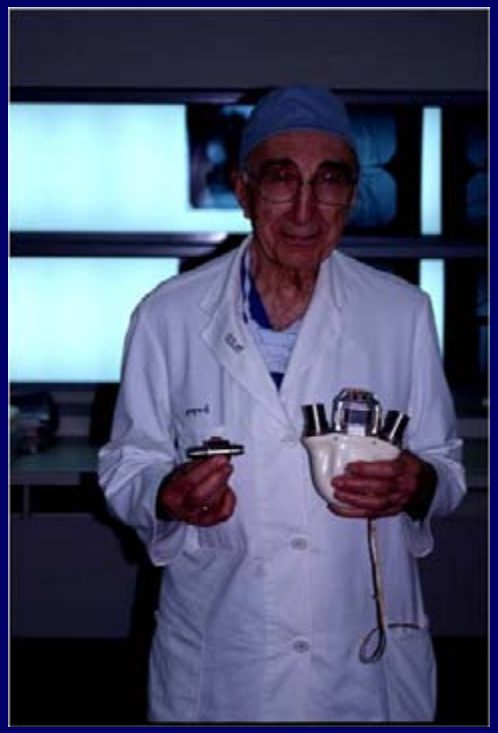
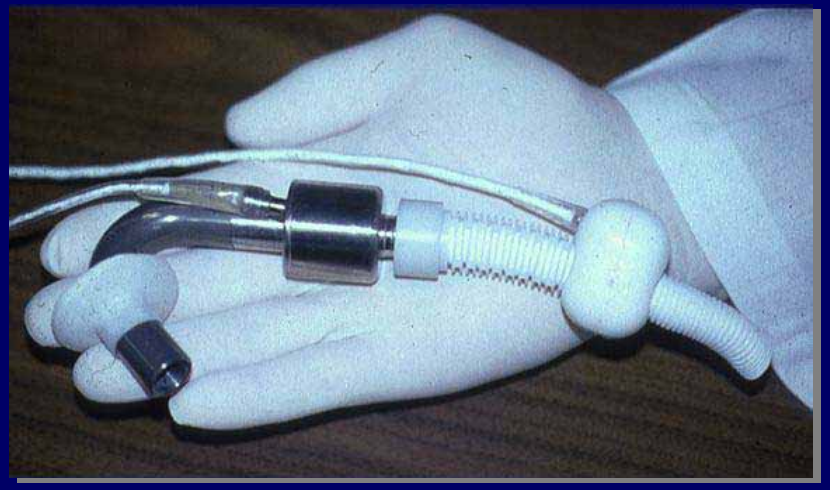
Biomaterial used for Vienna artificial heart

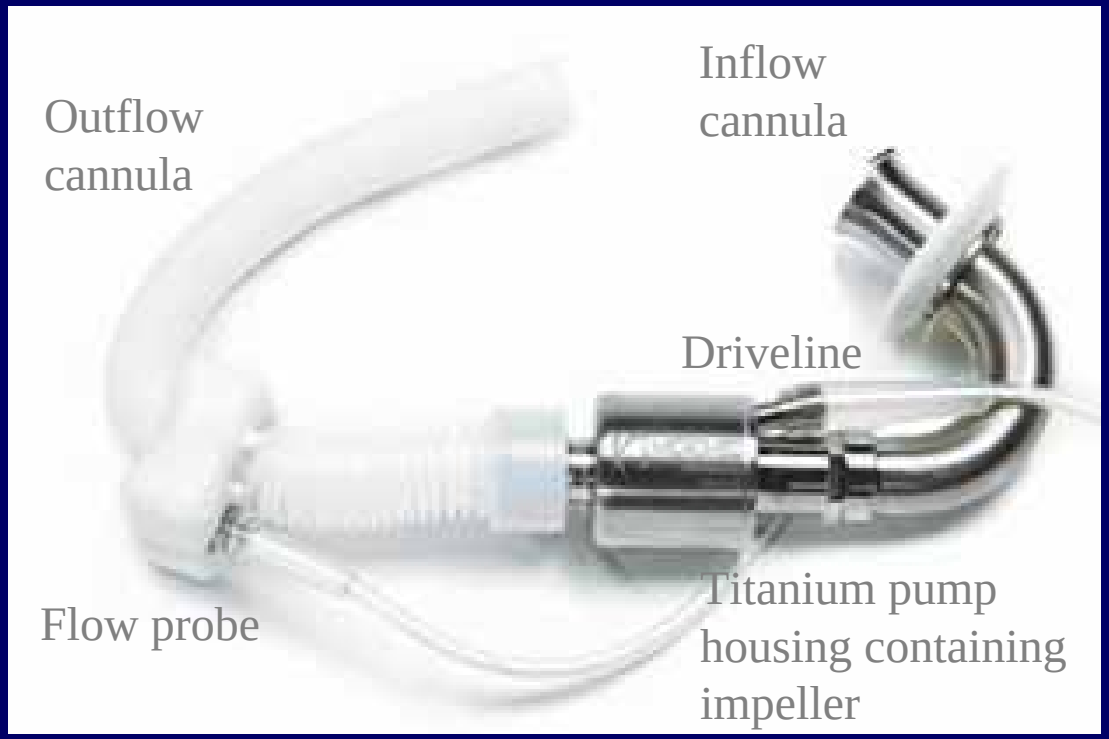
- Blood chamber:
  Thermoplastic
  Polyetherurethan
- Connectors:
  PTFE (GoreTex®)
  PET (Dacron®)
- Screw nuts: Titan
- Hardvalves: Carbon
- Driving line:augmented Polyurethan

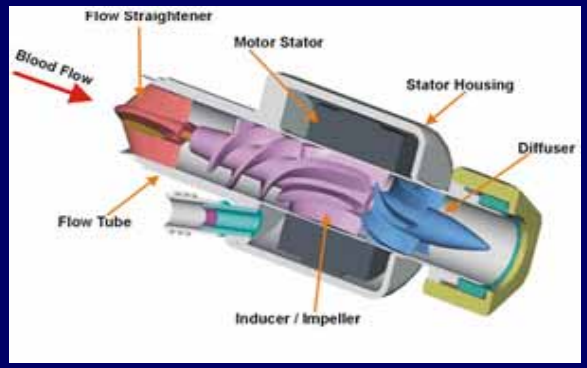
DeBakey VAD®





DeBakey VAD®





2nd generation axial flow device with mechanical bearings

Titan

- cp Titan, TiAl6V4
- Excellent blood rejection TiO_2
  - No corrosion
  - High bio-compatibility

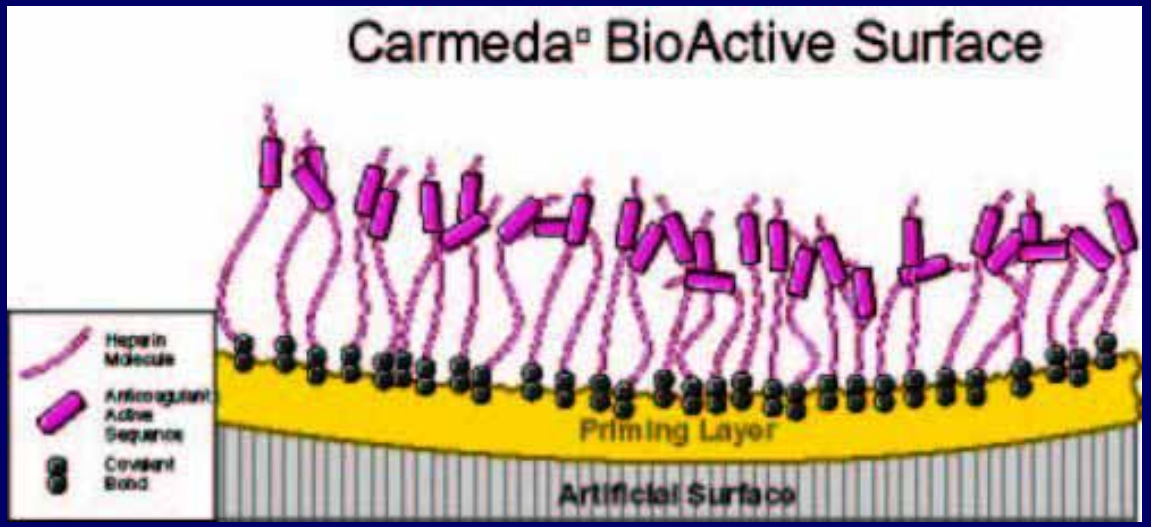
Application:

- VAD
- Mechanical Heart valves

www.thoratec.com

Heart lung machine

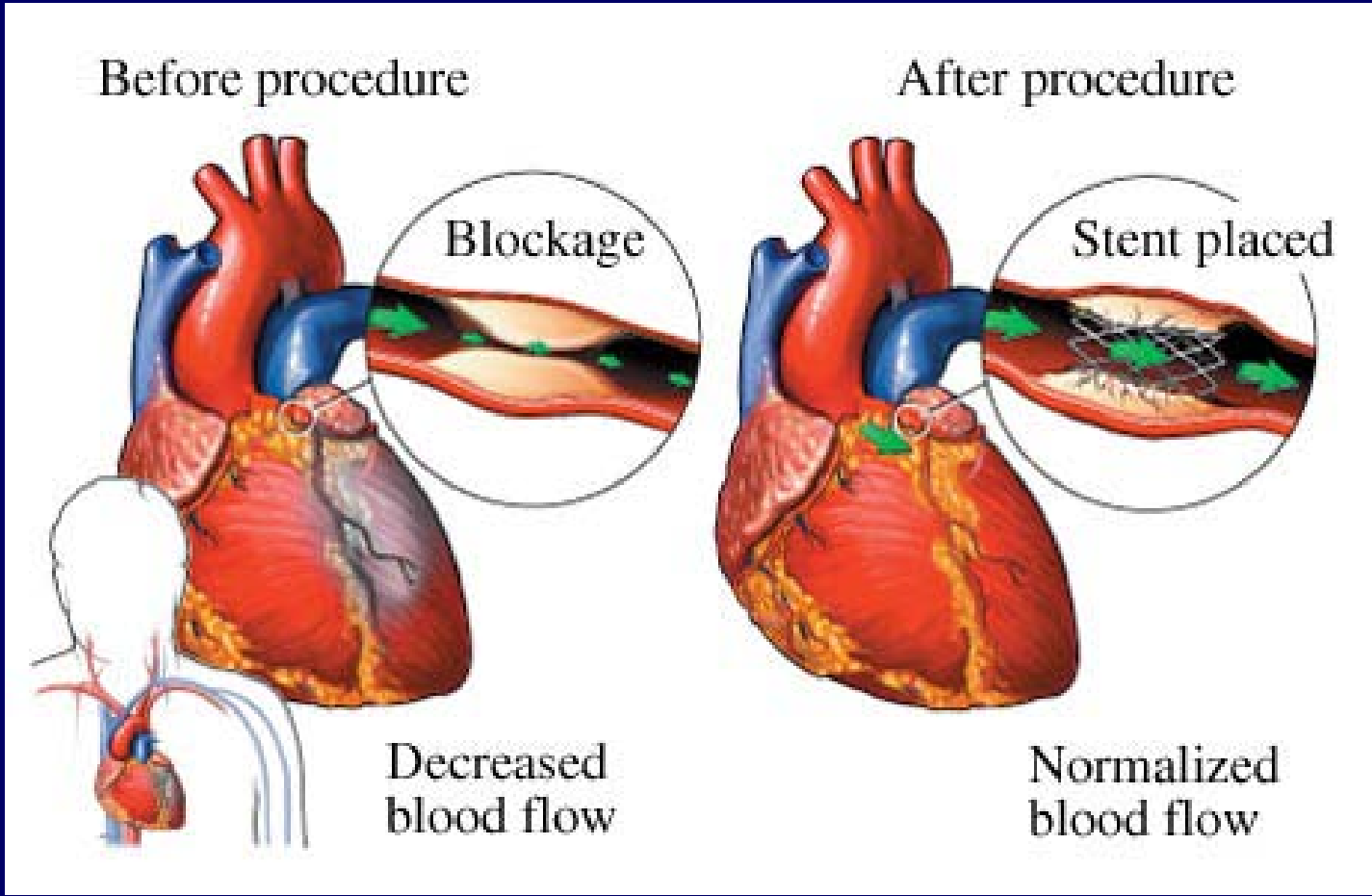
ECMO


Carmeda® BioActive Surface
Heparin Molecule
Anticoagulant Active Sequence
Covalent Bond
Priming Layer
Artificial Surface

Coronary stents

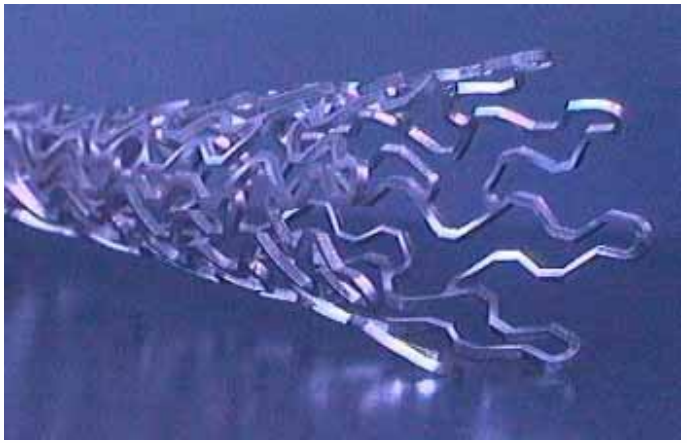
- Bar metal stents
- Covered stents

Coronary stents

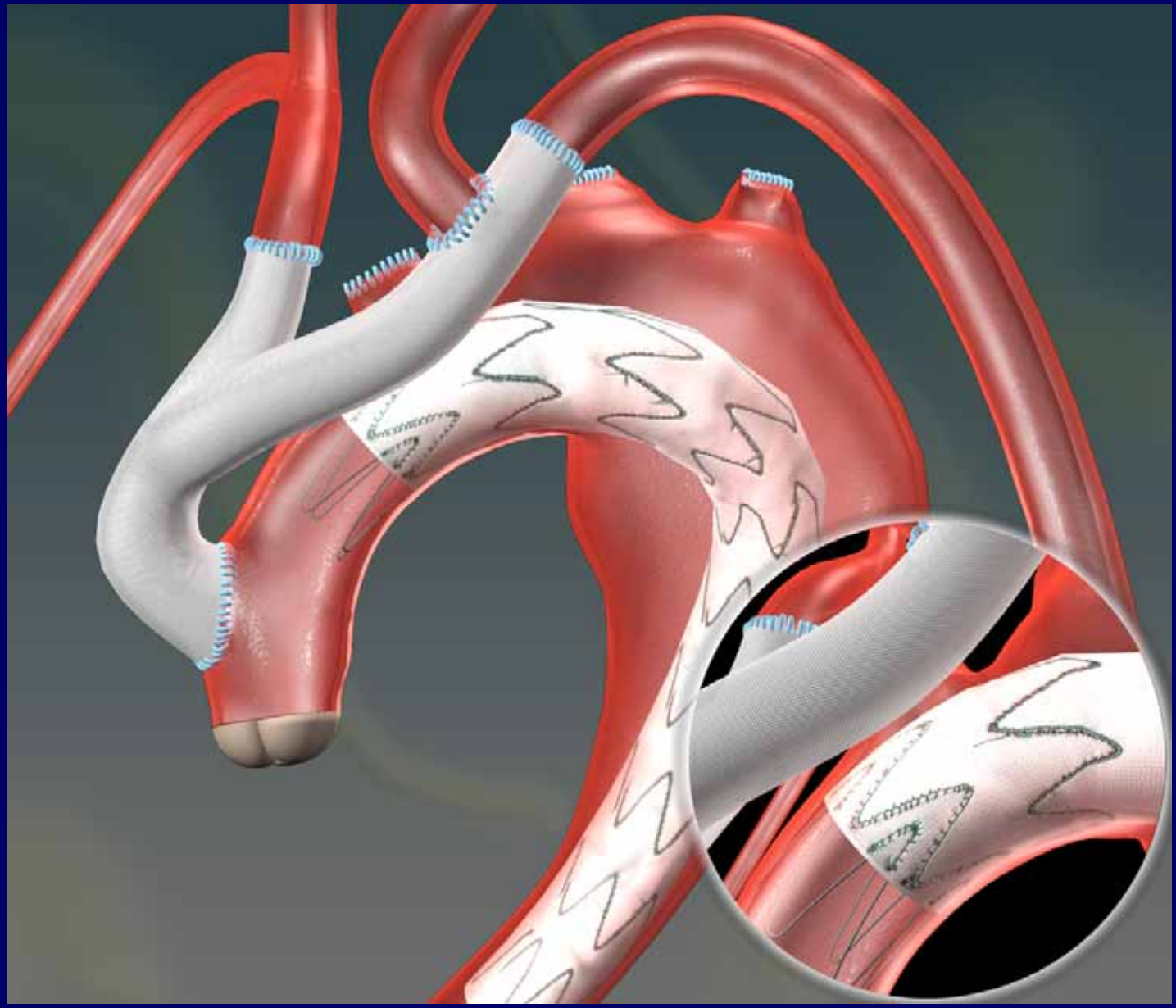


High-grade steel

- Mixture from CrNiMo, CoCrMo,
- Split corrosion
- High mechanical qualities
- Application
  - Stents
  - Hip-prosthesis



www.biosteel-net.de

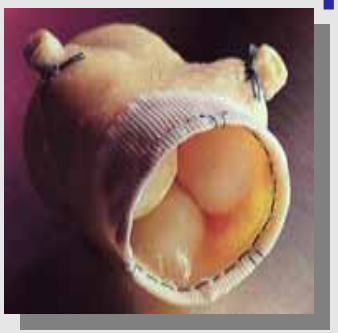


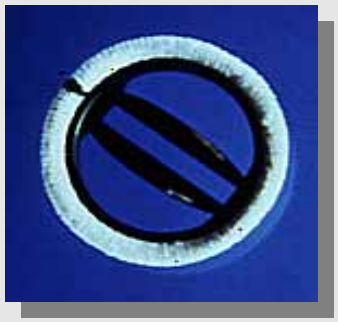
Artificial Heart Valves

- Mechanical prostheses
- Biological prostheses

Heart Valve Replacement - Today





Individualized patient oriented surgery





Pyrolytic Carbon

- Carbonization under exclusion of oxygen
- Inert und hemocompatibel because of not degenerated protein layer

- Application
  - Mechanical Heart valves

www.onxlti.com

Thromboembolic complications

- Design
- Material
- Site

Early Adverse Events

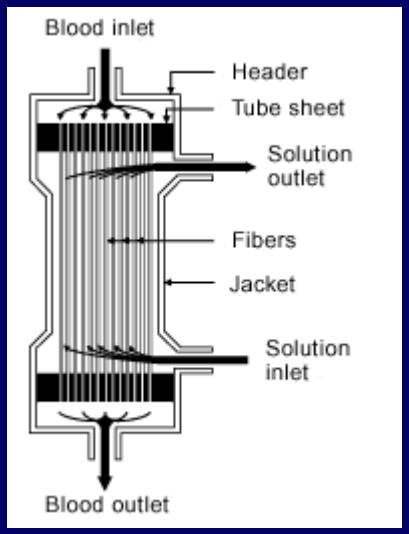
(< 30 days)

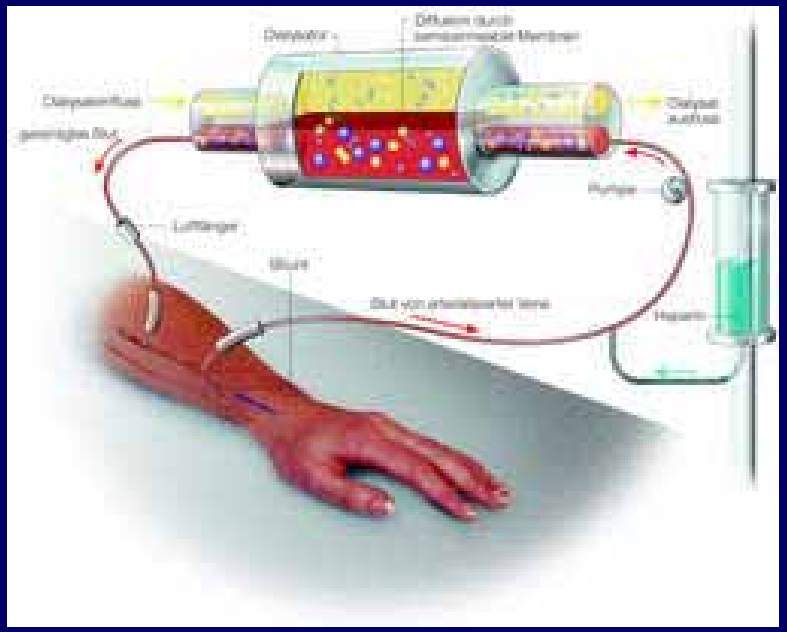
Complication % (N)	Aortic	Mitral
Thromboembolism	1.3 (4)	0.9 (2)
Bleeding Event (Major)	1.0 (3)	1.8 (4)
Paravalvular leak	1.7 (5)	0.9 (2)
Major PVL	0.7 (2)	0.4 (1)
Valve related mortality	0.3 (1)	0.4 (1)
Valve related morbidity and mortality	4.0 (12)	4.4 (8)
Total operative mortality	1.3 (4)	3.9 (9)
Valve reoperation	1.0 (3)	1.3 (3)

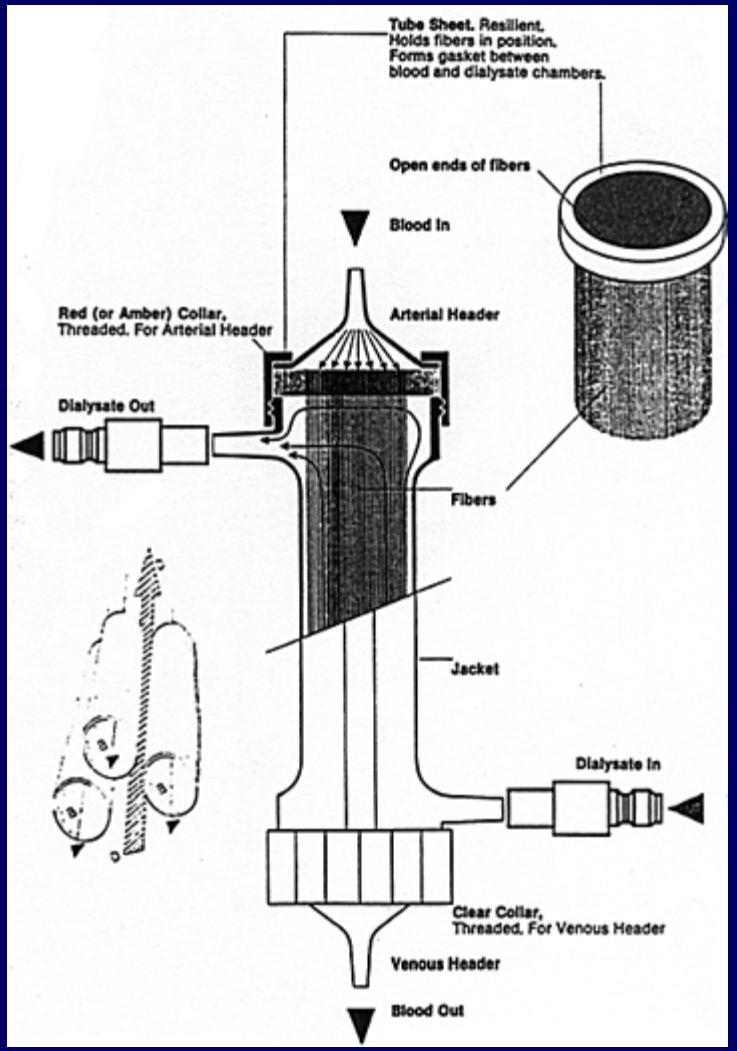
Tissue engineered heart valves

- Scaffold:
  - Biological
  - Artificial net
- Seeding with fibroblasts and endothelial cells

Dialyse


Blood inlet
Header
Tube sheet
Solution outlet
Fibers
Jacket
Solution inlet
Blood outlet




Tube Sheet. Resilient. Holds fibers in position. Forms gasket between blood and dialysate chambers.
Open ends of fibers
Blood In
Red (or Amber) Collar, Threaded. For Arterial Header
Arterial Header
Dialysate Out
Fibers
Jacket
Dialysate In
Clear Collar, Threaded. For Venous Header
Venous Header
Blood Out

SUMMARY

The contact between blood and artificial surfaces is a difficult problem

Almost all we implant is not biologic (PTFE, Dacron, Steal Titan, Silicon, ….)

Lot of research is done for surface covering:

- ‘BIO-covering’ like endothelial cell seeding
- Pharmacological coating with heparin, prostaglandines, ….