Biomedical polymers

(III) Artificial Heart - For patients with irrersibly damaged heart, the functions of the damaged heart may be taken over permanently or temporarily by an artificial pump. Synthetic elastomers and rigid polymers have been used extensively for the conuction of these devices. Unfortunately, most synthetic polymers accelerate the clotting of blood. Avoidance of the clotting process is depends on the design of the pump and presence or absence of turbulence as well as on the materials used for construction.

• Heart pump designs

The Auxiliary blood pumps to bypass or supplement the of a damaged heart until it can repair itself. many of the booster pumps have used a rigid housing, often made of reinforcfed epoxy resin, with an internal tube of silicone rubber.

Compressed air applied inside the rigid casing compresses the silicon or PU rubber inner tube which is connected to the aorta and this forces blood from the pump. values may be used to prevent back flow, or the compression cycle may be synchronized with the pumping motion of the heart.

A. related device is the intraaortic balloon, a 25cm * 2cm polyurethane ballooninserted in to the aorta which expands as compressed helium or carbon dioxide is pulsed in or out. Other devices use hemisphere of titanium, polycarbonate, or PMMA containing a PU diaphragm. Pulses of compressed air or carbon dioxide actuate the diaphragm and cause the pumping of the blood.

The total artificial heart pumps that can completely replace the living organ. They resembles the general structure of a human heart by which are actuated by compressed gas or oil.

- <u>Polymers for heart pumps</u>

A wide variety of polymers such as silicone rubber, polyurethane rubber, Dacron polyester, Teflon, polycarbonate, PMMA, PVC and pyrolytic carbon. Most of these materials cause blood clotting, destruction of red cells, or alteration of the blood proteins, although some are markedly better than others.

Polyurethanes are among the most commonly used flexible biomaterials. They have excellent flexing strength. The diaphragm in a heart pump would have to withstand about 90 million flexing motions without breaking over a 10 year period. Calcification of PU membranes is a problem during long-term use.

Silicone rubber is an ideal biomaterial. Its chemical inertness is impressive, and it is soft and flexible. However, it can promote blood clotting if the blood is flowing slowly, and it can fail after continuous flexing. Another problem is the tendency of silicone rubber to absorb fats from the blood, to swell, and eventually to weaken. Fluoroalkylsiloxane polymers or polyphosphazenes may prove to be more suitable for artificial heart applications.

The ability of a synthetic polymer to initiate the clotting of blood depends on the nature of the

Surface (Smooth surfaces are better than rough) and on the chemical and physical properties of the polymer. Because the inside lining of blood vessels is negatively charged, it has also been speculated that polymers with a surface charge might be more effective than neutral polymers.

- Cardiovascular applications

Heart valves and vascular prosthesis-

Polymers have been used extensively to correct cardiovascular disorders. Defective heart valves can be replaced by mechanical valves based on various designs. In one design, a ball of silicone rubber is retained inside a stainless steel cage. (Starr-Edwards ball-type heart valves constructed from a silicone rubber ball, a chrome-cobalt cage, and a Teflon ring for suturing to the heart tissue)

The silicone rubber is used because of it's inertness, elasticity, and low capacity to cause blood clotting. Valves of this type are still being used.

A more recent design makes use of a small, circular plates as a flap valve, with the flap made from pyrolytic carbon or poly (oxymethylene).

Another surgical practice is to implant modified (cross-linked) tissue heart valves from pigs ("porcine valves"). Devices fabricated from synthetic hydrogels may eventually replace porcine valves.

Aneurisms (balloon-like expansions of the arterial wall) can be repaired by reinforcement of the artery with a tube of woven polyester or PTFE fabric. Completely blocked arterial sections are removed and replaced by a tube of porous PTFE. The polymer is relatively noninteractive with blood from the polymer.