damage to the optic nerve, with resulting loss of vision. The main surgical treatment is to insert an opening that allows fluid to drain through the sclera/cornea into the subconjunctival space. For some patients, it is advantageous to place a drainage implant at this site to facilitate the process. The first successful device of this type was described by Molteno in 1969, and comprised a two-piece device consisting of a silicone drainage tube and a polypropylene plate.[64] The plate was sutured in place under a flap and had the function of maintaining the patency of the subconjunctval filtration reservoir during subconjunctival fibrosis. Since this time, a number of similar devices have been developed, typically with silicone drainage tubes but with plates fabricated from various polymers, including silicone and polymethyl methacrylate.[65]

Finally, there are a number of other uses for synthetic materials in ophthalmology other than for the lens or glaucoma drainage. These include artificial tear solutions for patients with dry-eye conditions.[66] Such solutions typically contain a variety of substances, such as methylcellulose, poly(vinyl alcohol), and hyaluronic acid, though formulations vary, and there is no ideal formulation to suit the majority of patients who suffer from dry-eye syndrome.[67]

Dentistry

The structure of a typical tooth is shown in Figure 1.4. The destruction of its fabric, dental caries, though preventable, is one of the most widespread diseases of civilisation.[68] Dental caries involves attack on both the enamel and the dentine of the tooth by acids that are generated as the result of metabolic activity of bacteria within the plaque that accumulates on the tooth surface. The principal acid that is formed is lactic acid, but acetic acid is also generated in smaller amounts by active caries.[69] Initial attack is quite localised on the surface of the enamel, but as it penetrates the softer dentine, it tends to balloon out, and undermine the surface layer of enamel.

Diet makes the major contribution to dental decay, especially the presence of refined sugar. Sugars are the food source for bacteria in the plaque, and are metabolised through to the acids that cause the damage. The pH of the mouth drops rapidly after the intake of sugar, as was first demonstrated by Stephan in his classic study.[70] He gave his subjects a mouth rinse of glucose solution, then measured the pH at the surface of the tooth over the next hour. His findings are shown in Figure 1.5.

The critical factor in caries development is the time for which the pH stays below 5.5. Stephan's results showed that in patients who already had a significant amount of tooth decay, the pH stayed below this critical value for longer than it did in those without decay.

Sucrose, and to a lesser extent glucose, is metabolised to form intracellular and extracellular polysaccharides. These sugars enable the bacteria to cling on tenaciously to the tooth surface, and provide a source of energy for continued metabolic activity. The main species responsible for caries is *Streptococcus mutans*, though other bacteria are also involved.

Tooth decay is mainly a problem among the young, who tend to consume

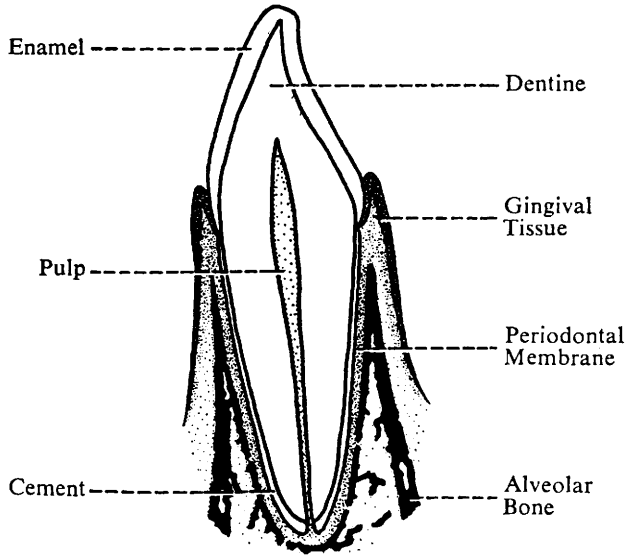

Figure 1.4 *structure of a tooth (incisor)*

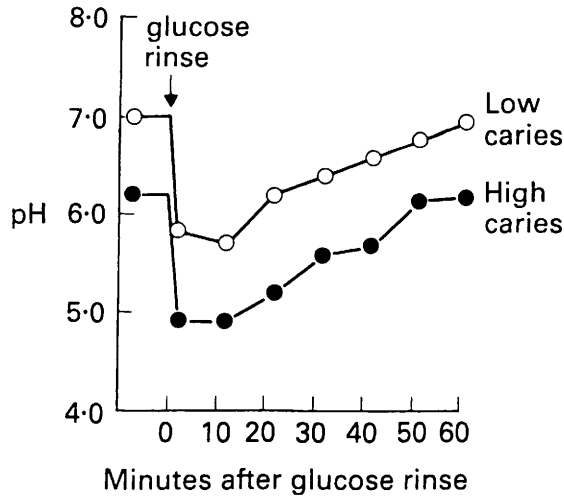

Figure 1.5 *Curve of pH vs time following administration of a glucose drink* (from Stephan[70])

sweets, and also among the elderly, who often suffer from dry-mouth syndrome as a side effect of medication, and therefore resort to consuming sweet drinks and to sucking boiled sweets to relieve the discomfort. These patients are increasingly likely to have at least some of their natural teeth, and these teeth become susceptible to loss from caries as a result of the increase in sugar consumption.

Tooth decay is generally repaired by removing the carious tissue and replacing it with an appropriate restorative. The most widely used and cost effective materials for this purpose is silver amalgam, though there has been considerable work on polymer-based restorative materials in recent years, and this has led to tooth-coloured alternatives to silver amalgam. These are generally bonded to the tooth using either the inherent adhesive nature of the restorative, or special bonding agents.[71]

Tooth loss, which may result from severe caries, or from periodontal disease in middle life, has conventionally been treated by providing dentures, either full or partial, depending on the severity of the loss. More recently, partial tooth loss has been treated with the use of implants.[72]

Dental implants have mainly been used as replacements for tooth roots or tooth root analogues. They have also been used successfully to facilitate orthodontic tooth movement and also for prosthetic treatment of craniofacial defects. In selecting a patient for implant treatment, certain biochemical and biomechanical requirements should be taken into account. For example, there should be no disease that would compromise wound healing. Conditions such as diabetes, osteoporosis and various cardiovascular diseases may cause concern, although they do not necessarily mean that implant treatment cannot be used.[73] In general, though, patients should be in good health, be psychologically stable, and have adequate bone density at the site of the proposed implant. Dental health should be good and especially healthy oral tissues are required.

The main material used for dental implants is titanium and its alloys. These are used because of their excellent bone biocompatibility and ability to osseintegrate.[74] To replace teeth, titanium support structures are implanted into the jaw, and used to support ceramic teeth of excellent aesthetic appearance within the mouth.

As well as titanium-based implants, other materials have been used in dental implantology. For example, synthetic hydroxyapatite in particulate form has been used to improve healing in patients who have had periodontal surgery.[75] When used in this way, the hydroxyapatite particles become surrounded by collagen early in the healing process, and gradually diminish in size. At the same time, bone is gradually deposited in the region around the particles. Synthetic hydroxyapatite of this type may also be used to augment the alveolar ridge in edentulous (*i.e.* toothless) patients, thereby providing improved support for dentures.

Wound Dressings and Artificial Skin

Wounds to the skin in terms of minor cuts and abrasions are common occurences, and usually need no more elaborate treatment than to be kept clean and dry. For more extensive skin damage, for example severe burns, synthetic materials are used, either in the form of sterile dressings or as artificial skin. These limit the entrance of foreign matter into the skin and also prevent loss of fluid and heat from the surface of the skin.