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REVIEW

# The clinical applications of human amnion in plastic surgery



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## KEYWORDS

Human amnion;  
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**Summary** Since the early 1900s, human amnion has been applied to a wide variety of clinical scenarios including burns, chronic ulcers, dural defects, intra-abdominal adhesions, peritoneal reconstruction, genital reconstruction, hip arthroplasty, tendon repair, nerve repair, microvascular reconstruction, corneal repair, intra-oral reconstruction and reconstruction of the nasal lining and tympanic membrane. Amnion epithelial and mesenchymal cells have been shown to contain a variety of regulatory mediators that result in the promotion of cellular proliferation, differentiation and epithelialisation and the inhibition of fibrosis, immune rejection, inflammation and bacterial invasion. The full repertoire of biological factors that these cells synthesise, store and release and the mechanisms by which these factors exert their beneficial effects are only now being fully appreciated. Although many commercially available biological and synthetic alternatives to amnion exist, ethical, religious, and financial constraints may limit the widespread utilisation of these products. Amnion is widely available, economical and is easy to manipulate, process and store. Although many clinical applications are of historical interest only, amnion offers an alternative source of multi-potent or pluripotent stem cells and therefore may yet have a great deal to offer the plastic surgery and regenerative medicine community. It is the purpose of this article to review the clinical applications of human amnion relevant to plastic surgery.

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## Introduction and history

Prior to the realisation of its medical and surgical applications, human amnion was the focus of myth and superstition. Being born with the fetal membranes or “caul” intact was considered extremely lucky. Children were gifted with life-long happiness, the ability to see spirits, and protection from death by arms and drowning. The magical powers of

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the caul were not confined to the original bearer and could be transferred by inheritance or legitimate sale. As a result, the trade of caul amulets became extremely popular, particularly between seafaring men during the 1800s at the time of the Napoleonic War.<sup>1</sup>

In 1910, Davis reported on early experience with fetal membranes in skin transplantation.<sup>2</sup> Over the last century, the beneficial effects of amnion have been applied to burns, chronic vascular and diabetic ulcers, dural defects, intra-abdominal adhesions, peritoneal reconstruction, genital reconstruction, hip arthroplasty, tendon repair, nerve repair, microvascular grafts, corneal repair, intra-oral reconstruction and reconstruction of the nasal lining and tympanic membrane. More recently amnion has been shown to be a viable source of stem cells with a potentially exciting future in tissue engineering and regenerative medicine. Although many of these roles are of historical interest only, an awareness of this history is an important pre-requisite for future development and innovation. It is the purpose of this article to review past and present applications of human amnion relevant to plastic surgery and how it may contribute to our future.

## Anatomy and physiology

Amnion forms during the transition of the morula into the blastocyst at approximately 7-days following fertilisation.<sup>3</sup> Amnion is between 0.02 and 0.05 mm thick and consists of five distinct layers: (1) epithelium, (2) basement membrane, (3) compact layer, (4) fibroblast layer, (5) spongy layer (see Figure 1). The innermost epithelium consists of a single layer of cells in direct contact with amniotic fluid. Microvilli at the apical surface of these cells play an important role in amniotic fluid homeostasis.

The basement membrane border of the cells contains blunt projections that inter-digitate with similar processes in the basement membrane, forming a densely adherent bond. The basement membrane is a thin layer composed of reticular fibers. The compact, fibroblast and spongy layers are referred to as the amniotic mesenchyme and originate

from the primary extra-embryonic mesoderm of the blastocyst. The mesenchyme contains collagen I–VII and non-collagenous proteins such as elastin, laminin, fibronectin and vitronectin. The compact layer is composed of a dense network of fibers and is almost entirely free from cells. Abundant type I, II and III collagen and elastin within this layer endow amnion with tensile strength and elasticity.<sup>4</sup> These properties help protect the fetus from mechanical stress and desiccation. The fibroblast layer is the thickest layer and is composed of a loose fibroblast network within a matrix of reticulin. The outermost spongy layer represents the transitional layer between amnion and chorion and is composed of bundles of reticulin within a background of mucin. The two layers are loosely adherent, allowing a degree of gliding during gestation and easy separation by blunt dissection during harvest.<sup>5</sup>

In spite of being devoid of vascularity, nerves, muscles and lymphatics, amnion is highly metabolically active.<sup>5</sup> Oxygen and nutrients are obtained by diffusion from amniotic fluid and chorionic vasculature. The epithelial layer is a source of prostaglandins, particularly prostaglandin-E<sub>2</sub>, and is thought to play an important role in the initiation and maintenance of uterine contractions.<sup>6</sup> The epithelium also contains human chorionic gonadotrophin receptors that regulate prostaglandin production and activity. Epithelial cells manufacture multiple vasoactive peptides, growth factors, cytokines and extracellular matrix (ECM) proteins.<sup>5</sup> These biological factors may reside in the epithelium or may be transported and accumulated in the mesenchyme where they act as a reservoir from which the amnion exerts its therapeutic effects following transplantation.

## Mechanism of therapeutic effect

### As a barrier and analgesic

The application of amnion to a wound bed prevents desiccation and excessive fluid loss and provides an analgesic effect by protecting exposed nerve ends from the environment.

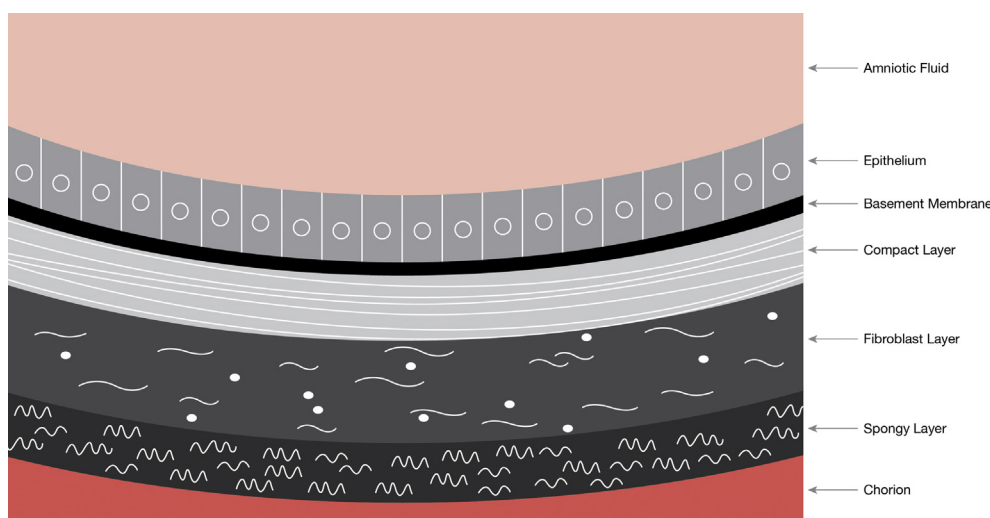


Figure 1 Schematic of amnion structure.

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