INTRODUCTION
Transdermal drug delivery is the technique of drug administration through the skin. This is a rapidly growing area which has several advantages over the conventional oral administration and hypodermic injection methods. The first drug to be successfully delivered via a transdermal patch was the anti-motion sickness drug scopolamine, in 1979. The following year saw the arrival of the nicotine patch, which raised the profile of transdermal drug therapy in both the scientific community and consumer market. The functionality and structural make up of the transdermal patch has evolved significantly over the past 30 years. Today, there are 19 different delivery systems, which have the capacity to release a plethora of drugs into the body.

WHY TRANSDERMAL DRUG DELIVERY?
Although oral administration and vaccination have been used for many years, transdermal drug delivery can provide solutions to some long-standing problems:

• Transdermal drug delivery by-passes the liver, which can prematurely metabolize drugs, as opposed to orally administered drugs.
• Hypodermic needles cause trauma at application site and create hazardous medical waste, which pose the potential risk of disease transmission.
• Transdermal patches are non-invasive, disposable and can be self-administered. They can release drugs for sustained periods of time.
• Cost-effective

1st GENERATION TRANSDERMAL PATCHES
These pioneering transdermal patches were able to contain and release low molecular-weight, lipophilic drugs at therapeutic doses. Drug transport occurs through intercellular lipid pathways in the stratum corneum (Figure 1). The first generation of patches were intended for therapies that did not have any specific dosage patterns or drug release profiles.

2nd GENERATION TRANSDERMAL PATCHES
These patches incorporated methods to enhance skin permeability (see Figure 2). Three enhancers that were mainly used were:

Iontophoresis: This increases skin permeability by the application of a constant, low voltage current. It also acts as an electrical driving force for drug transport and is applicable to small ions and some charged macromolecules. It is currently being used to administer rapid doses of lidocaine for anaesthesia.

Chemical enhancers: The role of these chemicals is to release amphiphilic molecules e.g. Azone, which disrupt the organisation of the lipid bilayers of the stratum corneum.

Non-cavitational ultrasound: Ultrasound waves disrupt the lipid structure of the stratum corneum, hence increasing permeability. This is applicable to small, lipophilic molecules.

3rd GENERATION TRANSDERMAL PATCHES
These target the stratum corneum directly using a whole array of methodologies:

Electroporation: This delivers a short, high voltage pulse which disrupts the lipid bilayers in the stratum corneum. The electric field lasts for milliseconds, but the remaining driving force for the diffusion of drugs remains for hours.

Cavitational ultrasound: Ultrasound waves instigate the formation, oscillation and collapse of cavities/bubbles. Bubbles that oscillate and collapse at the stratum corneum, disrupt its structure; increasing permeability.

Microneedles: These are minimally invasive, solid microneedles. They painlessly pierce the stratum corneum to increase permeability by creating microscopic pathways that penetrate into the superficial dermis.

THE FUTURE
The incorporation of new and exciting drugs into next generation patch devices means that transdermal drug delivery will offer greater benefits in the pharmaceutical remit. Table 1 highlights drug and patch combinations currently under investigation.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Technique</th>
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<tbody>
<tr>
<td>Influenza Vaccine</td>
<td>Microneedles</td>
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<tr>
<td>Testosterone</td>
<td>Chemical enhancers</td>
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<td>Insulin</td>
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<td>Fertility Hormone</td>
<td>Iontophoresis</td>
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<td>Buprenorphine</td>
<td>Passive</td>
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Table 1: Drug and patch combination currently under development