

KEY

■ Tissue Engineering - First Wave

and cartilage. Biomolecular growth

factors forecast to be integrated into

Structural tissues like skin, bone

bioengineered skin

Future technological areas that our legislative system may not yet be equipped

applications?

LEGISLATIVE READINESS?

for neuroprosthesis?

■ Neuro-enhancement? Will advances in

our understanding of brain function result in enhancing as well as therapeutic

Is our legislative system prepared

gence of gene therapy technologies, embry

ning and selection and a growing understand

of the interaction of genetics and environmenta

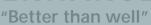
▶ ■ Whole organ regeneration?





# **ENHANCEMENT**

REGENERATIVE



MEDICINE





## **GENOMIC MEDICINE**

1997 – First gene-based targeted therapeutic Herceptin® for breast cancer enters the marketplace

1997 - 16% of new drugs based on biotechnology 2003 – Map of the human genome completed

#### NUTRITION



1996 – First commercial planting of GM Crops exhibits production, or "input", traits, like insect and herbicide resistance.





**INDUSTRIAL BIOTECHNOLOGY** 



# **ENVIRONMENTAL BIOTECHNOLOGY**

# **SECURITY** AND DEFENCE

Nations are increasingly adopting September 11 biometric technologies to identify travellers

### 1200S

TECHNICAL BOTTLENECK

A complete understanding of how stem cells

differentiate into various types of tissue

· The ability to replicate the vascular system

#### 2010



First true anti-aging product

forecast to emerge in the

marketplace





Potential availability of "artificial wombs"

Gene therapy emerges: RNA interference seen

as the technology "most likely" to enable it

■ Bio-nanotechnology-based diagnostics available

**LEGISLATIVE READINESS?** Is our

2015 - Apomictic or "self cloning" crop

**INTERDEPENDENCIES** Forecasts of widespread

uptake of commodity biofuels depend strongly on

the uptake of forecasted GM crop technologies to

technology forecast to enter the market

legislative system prepared for

bio-nanotechnologies?

Second Generation of GM Crops forecast to emerge.

These crops have enhanced "output" traits, for example

modified starch, fatty acid, lignin and protein content

to house premature babies to full term

■ Xeno-Cell Therapies Therapeutic use of GM pig cells to treat liver and pancreatic illnesses

■ Neuroprostheses Mind-controlled prosthetics ■ Bioartificial Organs Hybrid devices designed and devices, such as artificial limbs

from nerve damage or damaged by heart disease and Alzheimer's and Parkinson's diseases

Whole organ xenotransplantation?

to tide over and/or cure organ transplant patients

First meaningful data from

begin to give us a better

environmental factors

large-scale, population-based

longitudinal genetic projects

(like UK Biobank) which may

understanding of the complex interplay between genetic and

**POSSIBILITY SPACE? If** eases, will it be abused by professional sport

■ Ability to screen, select and store healthy embryos will continue to grow at a rapid pace

nd The populations of developed nations are living longer

oupled with this, perceptions about aging are changing from it

being something "natural" to something that can be "treated"

rend Continued growth of

estyle drug market and "off-label" use



2005-2010 - "Sperm sorting" technique emerges, enabling the accurate selection of the gender of an embryo through sperm testing and separation techniques prior to implantation

The growth of a "drug delivery" industry sub-sector

TECHNICAL BOTTLENECK

wave of genomic medicine

Data overload and the challenge of interpreting genomic and proteomic data Diagnostic technologies make up the first

Gradual growth of personalised "gene-based"

therapeutics and use of DNA chip diagnostics

TECHNICAL BOTTLENECK

By 2007, 50% of clinical trials are forecast to incorporate genetic testing of participants

Effectively delivering biological drugs to target sites

**LEGISLATIVE READINESS?** Is our legislative system prepared to deal with the privacy issues that may emerge through genetic testing?

Proteomics will build understanding of protein markers for disease, enabling early diagnosis

d Market fragmentation based on sub-populations of patients and consumers

2015 - 40% of new drugs based on biotechnology

**CONVERGENCE** of health and food sectors. Personalisation of treatment and diet based ■ Nutrigenomics – diet based on on an individual's genetic profile

■ Stacked Traits Genetic modification of multiple traits in plants **DECISION POINT?** To GM or not GM? If marker-assisted breeding forecast to become common

individual genetic make-up

2009 --- 2013 marker-assisted breeding techniques forecast to be capable of producing

controlled, complex traits without the need for genetic modification

■Biopharming GM plants forecast to be used to produce 2010 Rapid DNA diagnostics for animal health forecast to be common therapeutic proteins for the production of drugs

■ Biopharming - 2008 Forecast emergence of GM livestock as "factories" to produce therapeutic proteins for use in biopharmaceuticals

**CONVERGENCE** between industrial and ag-bio sectors via the use of plants and animals as factories

**DECISION POINT?** Advances in animal

5-10% of transport fuels based on bioethanol and biodiesel blends

■ Rapid improvements in enzyme and microorganism engineering set to lead to market penetration in non-traditional areas where cost-benefits evident

biorefineries emerging

Achieving Scale Prototype

Continued rapid growth of the functional foods sector

■ DNA diagnostic technologies enable more effective food safety monitoring

end Move among

end Strengthening

consumer resistance to GM crops entering

the food chain and the environment

onsumers in developing nations toward

self care and self diagnosis

INTERDEPENDENCIES The ability of industries to adapt to uptake commodity renewables will depend on their infrastructure. For example, in transport the uptake infrastructure and internal combustion engine technology design

**► Achieving Scale** Biorefineries becoming established and diversifying into the production of multiple product streams

Bioplastics, biofuels and other renewable commodity products making inroads into petrochemical markets

2010 → Bioplastics make up 10-20% of global plastics market

biosensing devices) start to play an increasingly mportant role in environmental management

own native flora and fauna in NZ?

■ The emergence of new viral diseases like SARS and Asian flu coupled with biodefence measures is resulting in greater efforts being put into national pandemic planning strategies

POSSIBILITY SPACE? ses and bacteria from scratch. There is potential for

■ Achieving Scale - 2020 Larger-scale bioenergy production capability 2015 → Bioplastics make up 30% of global plastics market **CONVERGENCE** of environmental and industrial applications via the development of sustainable industrial processes and renewable products

improve crop yields

■ Third Generation of GM Crops

drought and salt

Therapeutic food and crops which are

resistant to environmental stresses like

Hydrogen fuel cells?

TECHNICAL BOTTLENECK

Storage of hydrogen

■ Diagnostic biotechnologies (DNA chips and

2005-2010 Forensic science applications

are more portable, able to process smaller

DNA samples in real time

2004 → Bioplastics make up 5% of total global plastics market

> LEGISLATIVE READINESS? Are we adequately prepared to protect or derive benefits from bioprospecting our

■ Biodefence R&D spending, particularly in the US, targeted at vaccine and anti-viral drug development and biosensing technologies, with resulting spin-offs for civilian

markets, for example environmental monitoring, food safety and drug manufacturing