Eyeing Up Regenerative Medicine

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EST 1955
Why is stem cell research so important?
What is a Stem Cell?

A single cell that can ....

.... replicate itself many, many times

.... give rise to many cell types
Where do Stem Cells Come From?

- Embryonic Stem Cells
  - 3-day Embryo
  - 5-7 day Embryo
  - 6-week Embryo

- Foetal Stem Cells
  - Infant

- Adult Stem Cells
  - Adult
The cornea is replenished and repaired by stem cells at the limbus.
Limbal Stem Cell Deficiency

Day 55

Day 265

Day 609
Limbal Stem Cell Expansion

Day 798

1mm biopsy

Culture in laboratory
Limbal Stem Cell Expansion

- Day 20 in culture
- Expanded cells ready for transplant
Back to the patient

- Day 819
- Corneal transplant with expanded stem cell transplant
How’s the patient now?
Aims

• To improve treatment for limbal stem cell deficiency

• To define stem cell units as transplantable elements

• To provide long term regeneration of the limbus
Human tissue for research
Human laboratory model
Identification of stem cells

Sphere Forming Ability
Stem Cell Markers
Functionality
Isolated stem cells form clonogenic spheres

Spheres Label with p63
Functionality

• Differentiation

• Division

• Migration
Do holoclones contain functional stem cells

Differentiation

Holoclones produce cells of a different type as shown by differential protein expression
Do spheres contain functional stem cells?
Can stem cell spheres respond to injury?

Unwounded

Wounded
Can stem cell spheres respond to injury?
Can stem cell spheres respond to injury?

Unwounded

24 Hours

Wounded

Differentiation

control  wound

24hr
Can stem cell spheres respond to injury?

Unwounded

4 Days

Wounded

Division

control  wound

4day
Can stem cell spheres respond to injury?

Unwounded

7 Days

Wounded

Migration

control | wound
7day
Can stem cell spheres restore the limbus?
Can multiple spheres form a complete limbus?
Next Steps?

- Characterise the integrity of the regenerated limbus
- Test the ability to reform a limbus in human tissue
- Clinical trials of transplantation of stem cell spheres
Future uses of ocular stem cells

Stem cell spheres implanted deep into the cornea could produce cells capable of repairing corneal damage sustained due to diseases such as keratoconus.
Future uses of ocular stem cells

To replenish the crucial endothelial cells on the inner surface of the cornea that are lost during the progression of endothelial dystrophies.
Future uses of ocular stem cells

To reprogram stem cells into nerve cells that can be used to regenerate retinal function after functional loss caused by glaucoma or age-related macula degeneration
Thank you

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