Joint Clinical Research Centre (JCRC)

GENE THERAPY FOR THE – HEALTH & WELLBEING – OF UGANDANS

MARCH 2022

What is

DNA?

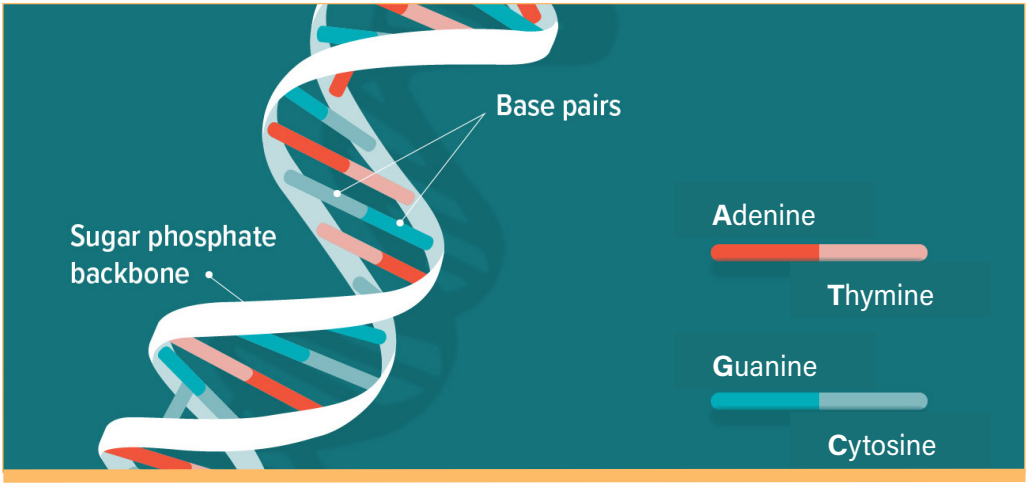
DNA is the material that carries all the information about how a living thing will look and function. It supplies the genetic instructions that tell the body how to develop, live and reproduce.

1. DNA is made up of chemical substances that are linked together to form a shape like a ladder

2. DNA also has chemicals called bases - A, T, G, C. Each base on one strand is joined to a base on the other strand

3. These four chemicals are repeated in different orders over and over again in each strand of DNA

The Structure of DNA

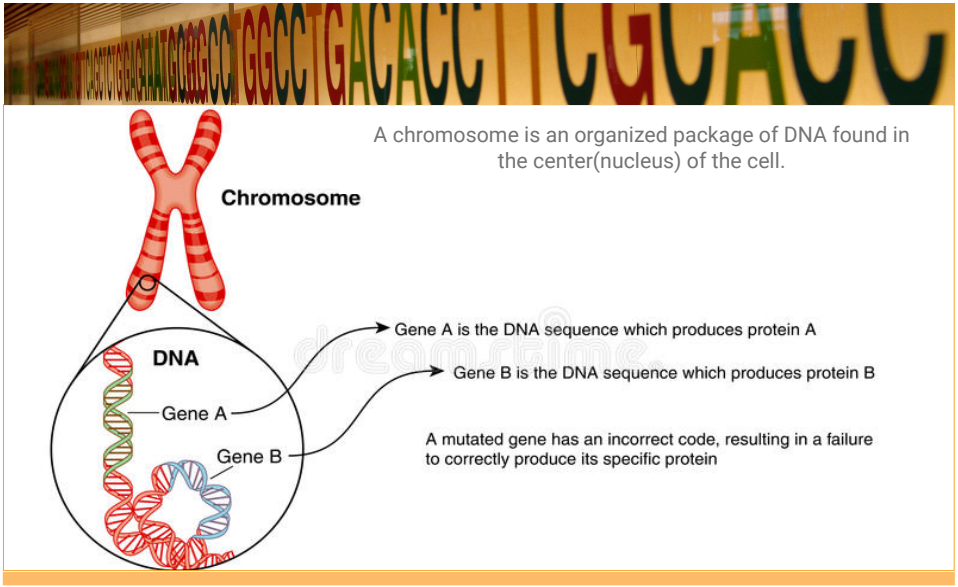


What are

GENES?

Similar to the way that letters in the alphabet can be arranged to form words, the order of the bases (A, T, G, C) in a DNA sequence forms genes which in the language of the cell, tell the cell how to make a specific protein leading to a particular characteristic or function.

Proteins perform most life functions and make up almost all cellular structures. Genes control everything from hair color to blood sugar by telling cells which proteins to make, how many of them, when to make them, and where.



What is

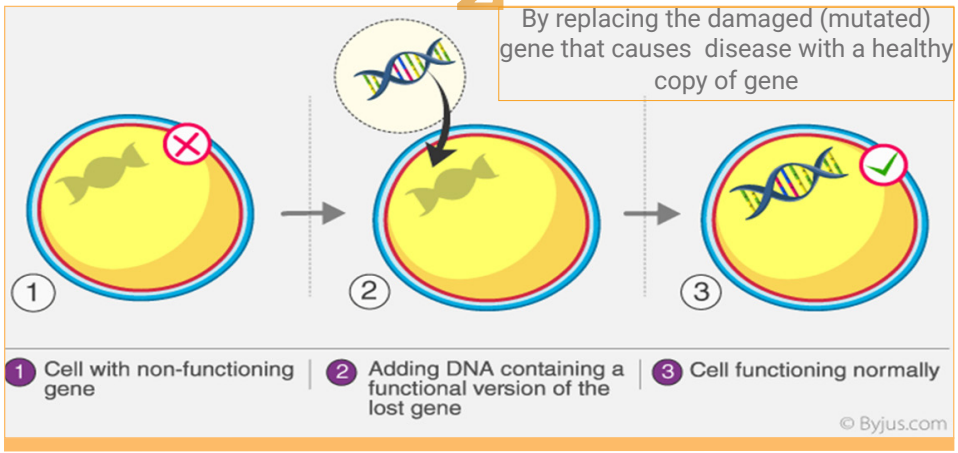
GENE THERAPY?

Gene Therapy is the **alteration of genes inside the organisim's cells** to treat or CURE disease. **Sometimes it is called Genetic Engineering.** Researchers are testing several approches to gene therapy, including;

1. Knocking out or "inactivating" a damaged gene that is not functioning properly

2. By replacing the damaged (mutated) gene that causes disease with a healthy copy of gene

3. Introducing a new gene into the body to help fight a disease

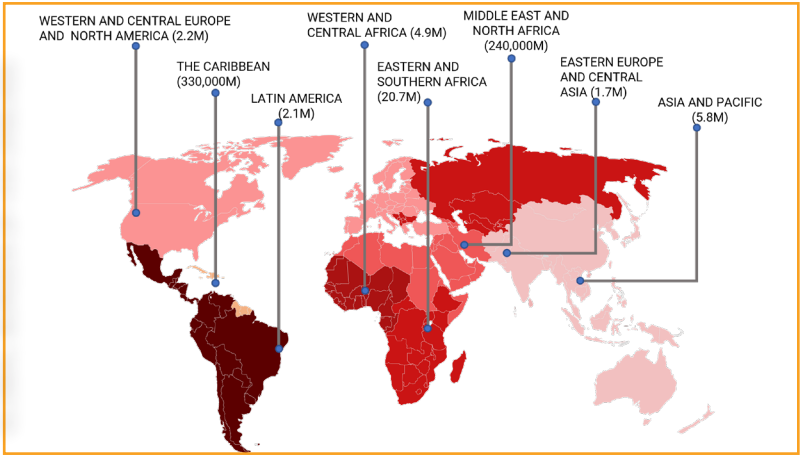


Our proposed activities do not include alteration of sperm or egg (germ) cells but rather body cells and therefore the changes are not heritable

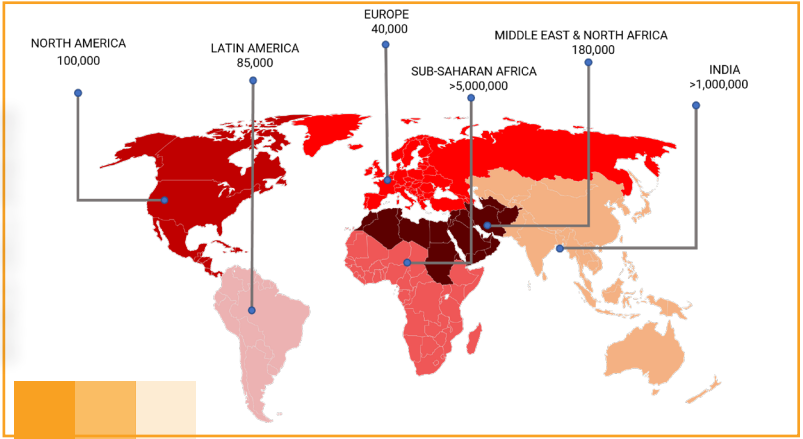
Why is

GENE THERAPY IMPORTANT FOR UGANDA

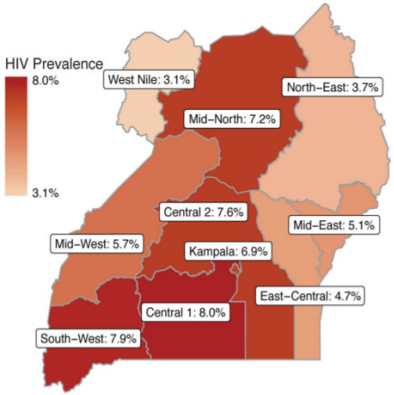
GLOBAL BURDEN OF HIV DISEASE



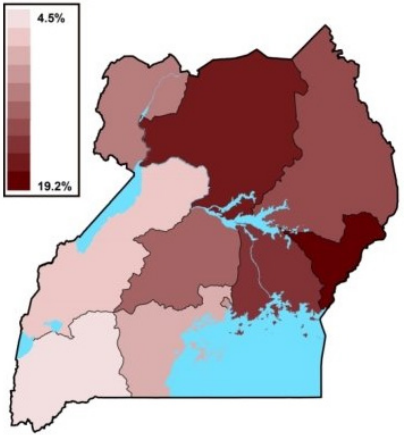
GLOBAL IMPACT OF SICKLE CELL DISEASE



BURDEN OF HIV DISEASE IN UGANDA



BURDEN OF SICKLE CELL DISEASE IN UGANDA



Why is

GENE THERAPY IMPORTANT FOR UGANDA

GENE THERAPIES:

The Next Generation of Medicine

- Despite expanded access to treatment, HIV remains a leading cause of death
- Pills need to be taken daily and patients get fatigued
- Adherence to ART regimens is inconsistent

1.4m

A cure could benefit 1.4m people living with HIV and **400,000** people living with Sickle Cell Disease, today!

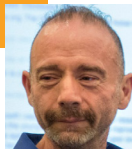
- HIV resistant viral variants have emerged and threaten effectiveness of HIV treatment programs
- Hard-fought progress is threatend by stagnant funding and donor fatigue
- Sickle Cell Disease (SCD) is the most common blood disorder
- Uganda has the 5th highest burden of Sickle Cell
- Diagnostic capacity is low
- Stigma and denial are common
- There is limited funding to support management of SDC

News of

CURES SPARKS HOPE

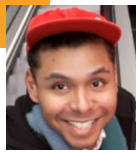
Victoria Gray
First patient with sickle cell disease to be treated with cells modified using one of the fastest gene-editing tools called CRISPR cas-9

Photo credit: NPR



Timothy Ray Brown
The Berlin Patient
1st person cured of HIV. There are now 4 people cured from HIV

Photo credit: Fred Hutch

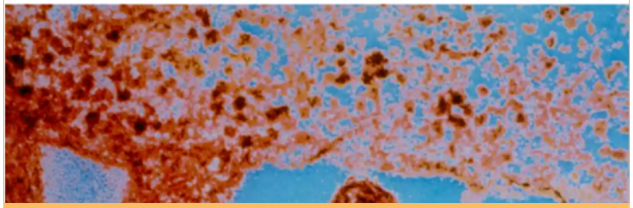


Adam Castillejo
The London Patient
2nd person cured of HIV

Photo credit: POZ

Third person apparently cured of HIV using novel stem cell transplant

Patient is mixed-race woman treated in New York using umbilical cord blood, in technique raising chances of finding suitable donors



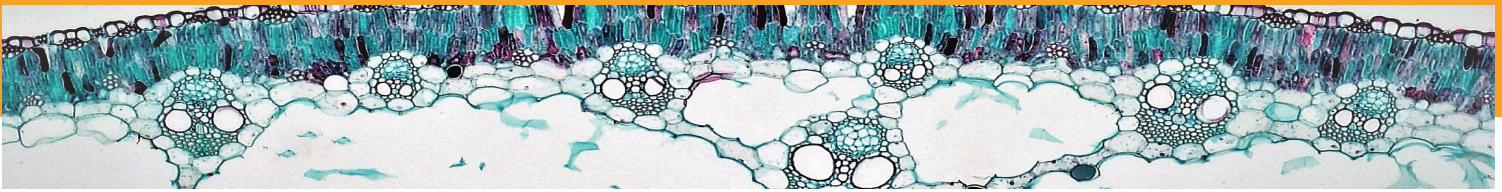
Antibody-based treatment

One person remains undetectable without HIV drugs almost four years after using an antibody-based therapy

Antibody enabled other people sensitive to it to stay off ART for at least three months

Gus Cairns | 16 February 2022

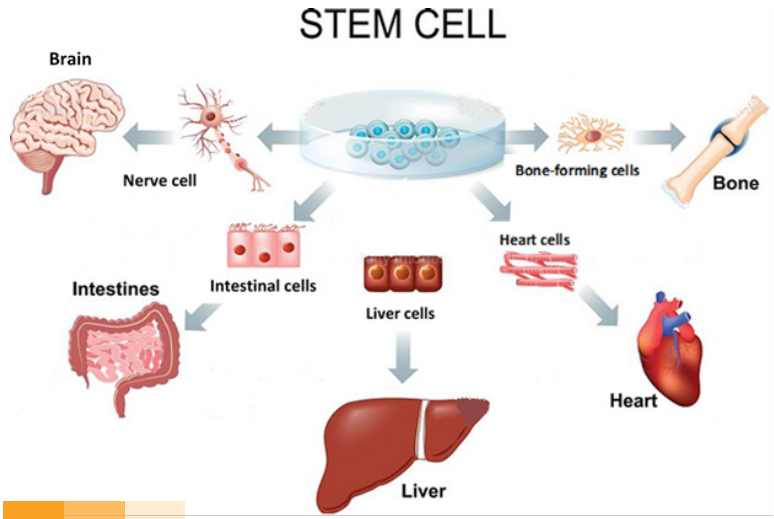
CROI 2022



What are

STEM CELLS?

These are cells in the body that are able to produce all of the other cell types that are needed. They are present in all of us from birth throughout life.



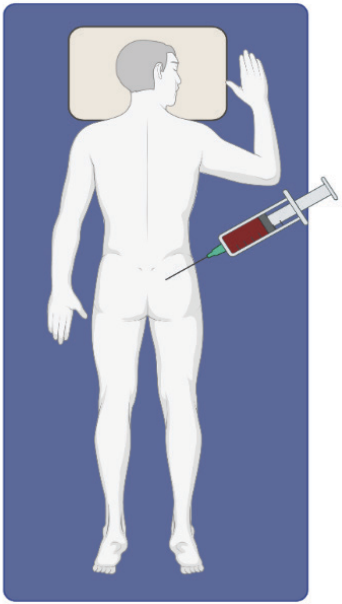
They can **reproduce themselves** to make many more cells

OR

Develop into special cells that carry out special functions in the body such as the skin, blood, muscles and nerves

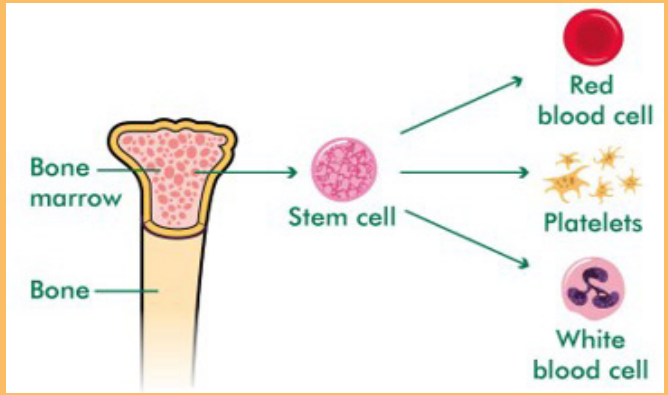
Which blood

CELLS COME FROM STEM CELLS?



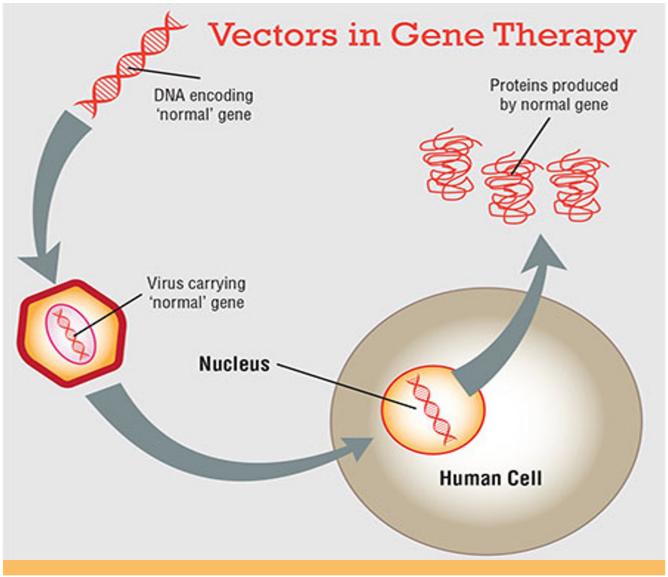
Patient

Blood-forming cells also known as blood stem cells are produced in the bone marrow. There are 3 main types of blood cells: red blood cells, white blood cells and platelets



How is

GENE THERAPY DELIVERED TO BLOOD STEM CELLS?



Gene therapies require carriers to deliver the gene of interest to the nucleus of the cell

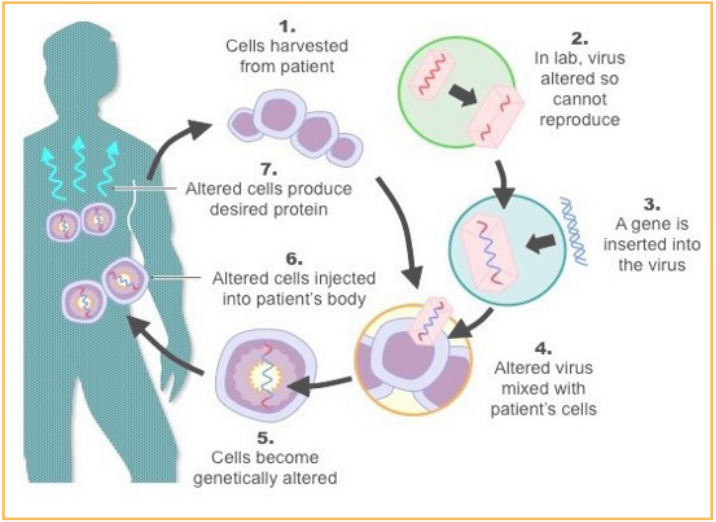
Vectors carry the healthy gene (gene of interest) to the nucleus of the target cell

Virus vectors are the most common type of carriers used to deliver gene therapy to blood stem cells

How

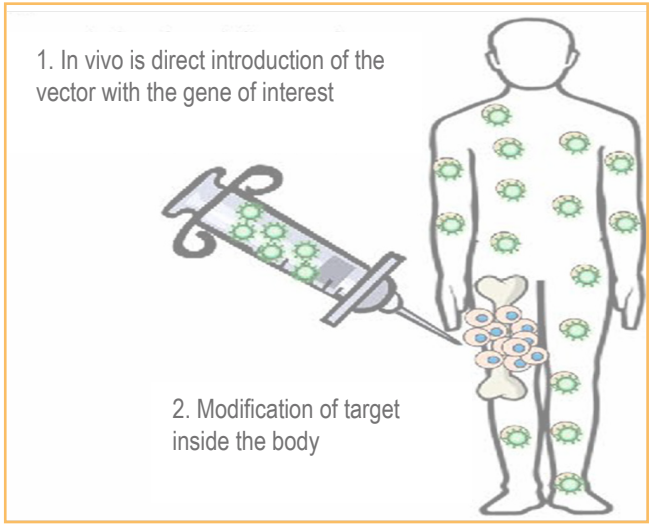
GENE THERAPY IS PERFORMED?

Outside the body (Ex-vivo)

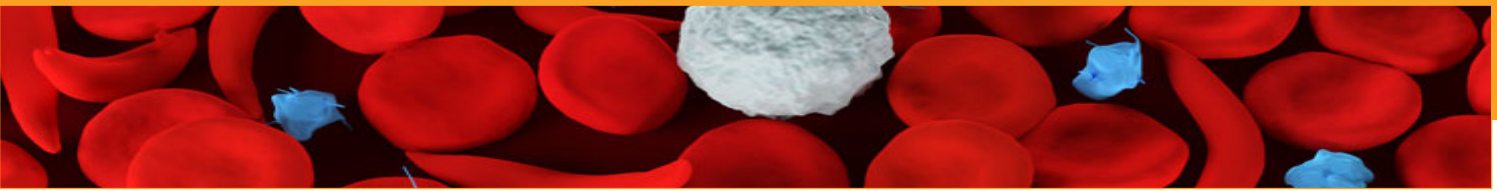


- Patient's blood cells are collected from the bone marrow or blood
- A vector/carrier with the gene of interest is introduced to these cells in a laboratory
- The cells with gene of interest are multiplied to produce more copies
- These copies are introduced into the patient's body

Inside the body (In-vivo)



- A vector/carrier with the gene of interest is directly introduced into the patient's body via a syringe.
- The introduction of the gene of interest into the blood cells is done directly in the body.



How do we

GET BLOOD STEM CELLS FOR GENE THERAPY

Directly from the bone marrow

A

Bone marrow is collected from the pelvis

From the blood stream through the apheresis procedure

B

Blood stem cells are moved or "mobilized" out of the bone marrow into circulation with drugs like plerixafor

The Apheresis procedure involves separation of blood components:

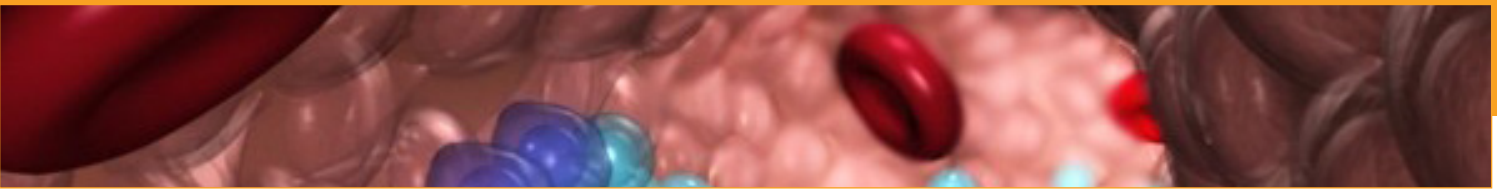
1. Removing whole blood from a donor or patient themselves
2. Separating/filtering that blood into individual components so that one particular component is removed
3. Re-introducing the remaining blood components to the patient's blood stream

How are

GENETICALLY ENGINEERED BLOOD CELLS PREPARED?

This table-top device can automate the whole process for gene transfer-also called **"Gene therapy in a box"**

It has potential to make these innovative treatments accessible to countries like Uganda



How will

GENE THERAPY BENEFIT UGANDANS?

PROMISING CURE

Gene therapies are the most promising cure strategy with the greatest potential for accessibility because they do not require a donor.

REGIONAL CENTRE OF CARE AND TREATMENT

Uganda is leading in efforts to make Gene Therapy accessible; positions us to be a Regional Centre for care & treatment translating into technology and economic development.

IMPROVED LIFE EXPECTANCY AND QUALITY OF LIFE

Targeting these two diseases first will significantly improve the life expectancy & quality of life of affected individuals, families & the nation translating into increased productivity.

TRANSFER OF TECHNOLOGY

Presents opportunity for technology transfer for local manufacturing of gene therapy products for local use & export.

INTELLECTUAL PROPERTY RIGHTS

Stronger stake in Intellectual Property Rights & Patenting.

Possible risks of

GENE THERAPY

- Unwanted immune system reaction: however, we have developed Quality Management Tools & Expertise pool
- Off-Target response: therapy gets into other cells of the body but this risk is minimized because the cells are purified before they are given back to the patient
- Cancer: this is still a theoretical possibility as no patient on this therapy to date has reported
- New infections because the carrier (viral vector) used to deliver the gene therapy recovered its original infectious capability or combined with another virus the patient was exposed to

The vision for

HIV & SICKLE CELL DISEASE MANAGEMENT

These treatments could be:

ONE-TIME

Administered in just a single dose

CURATIVE

Acutely focused and locally targeted on the biology of the disease

VALUABLE

High impact on quantity and quality of life, with great clinical, economic, and social value

SAFE

Improved safety profile, avoiding adverse events and challenging medical procedures

POTENT

Transformative efficacy improvements over standard of care

DURABLE

Sustained, life-long benefits

Questions?

CONTACT US NOW

@JointClinicalResearchCentre

Lubowa Hill, Plot 101 Lubowa Estates
Off Entebbe Road
P.O Box 10005, Kampala, Uganda

www.jcrc.org.ug

+256 417 723000