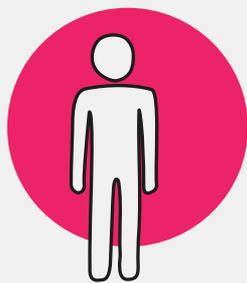


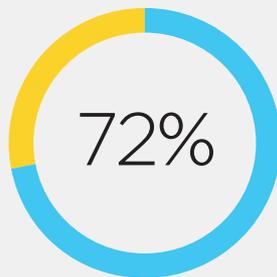
Gene therapy explained

Gene therapy is a promising treatment option that works by addressing the underlying cause of a disease.¹ It is currently being studied for a number of conditions, including rare diseases.²



3 million

people in the UK are affected by rare diseases³



72%
of rare diseases are genetic⁴



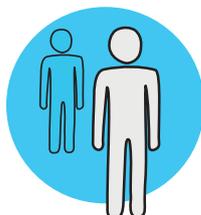
1 faulty gene

can cause a rare disease⁵

Faulty genes are responsible for

4,440

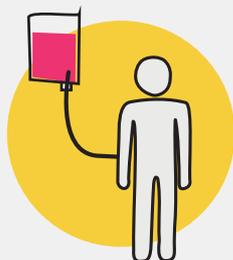
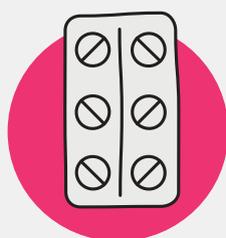
types of rare diseases⁴



Some affect tiny populations, such as progeria, which **rapidly ages children**⁶



Others affect thousands or millions worldwide, such as blood-related genetic disorders, like **sickle cell disease** and **haemophilia**⁷

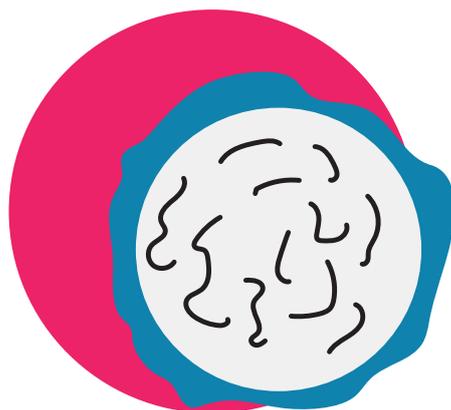


Most treatment options for genetic diseases are limited to symptom management⁸

Allogeneic haematopoietic stem cell transplantation

can address the underlying mechanism of some genetic diseases⁹

Even with 27 million+ donors registered in the Bone Marrow Donor Worldwide database, the **chance of finding a match when a related donor is not available is 1 out of 500,000**, due to a vast genetic diversity of tissue types^{9,10}



For certain diseases, **gene therapy** may also become a **treatment option**¹¹

3 approaches to gene therapy

1

GENE ADDITION^{11,12}

adds a healthy, working gene to help do the work of a faulty gene



Uses a delivery system, such as a viral vector to **insert new genes** directly into dysfunctional cells

2

GENE INACTIVATION^{11,13}

turns off a certain gene to help address an issue

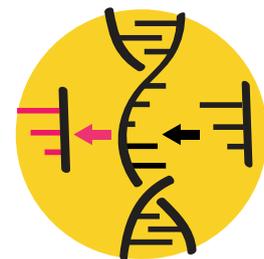


Can use viral vectors to break the DNA code to **turn-off a gene** in order to correct a disease

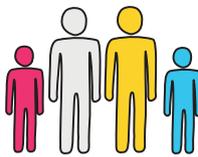
3

GENE REPLACEMENT^{11,13}

replaces a faulty gene with a healthy, working gene



Breaks the DNA code in a specific location to **repair a dysfunctional gene sequence** using a template or **inserts a new functional gene**



Changes from gene therapy are not passed on through generations as long as sperm and egg (germline) cells are not modified¹²



Gene therapies are a type of advanced therapy medicinal product (ATMP).¹⁴

The UK is becoming a leader in the innovation of new ATMPs:¹⁵



There are over **120** clinical trials testing ATMPs taking place in the UK.¹⁵



This represents **12%** of the global total, demonstrating the appeal of the UK for the clinical development of ATMPs.¹⁵



Currently, **27%** of ATMP companies in Europe are operating in the UK.¹⁶



ATMPs are an emerging field, with **9 therapies** licensed for use in the UK and counting.¹⁶

REFERENCES

1. U.S. Food & Drug Administration. What Is Gene Therapy? How Does It Work? 2017. Available at: <https://www.fda.gov/consumers/consumer-updates/what-gene-therapy-how-does-it-work>. Accessed 27 November 2020.
2. Nature Reviews drug discovery. Gene therapy for rare diseases. 2020. Available at: <https://www.nature.com/collections/bgdgddicj>. Accessed 27 November 2020.
3. Department of Health. The UK Strategy for Rare Diseases. 2013.
4. Wakap SN et al. Eur J Hum Genet 2020;28:165-173.
5. National Human Genome Research Institute. Genetic Disorders. 2018. Available at: <https://www.genome.gov/For-Patients-and-Families/Genetic-Disorders>. Accessed 26 November 2020.
6. EURORDIS: Rare Diseases Europe. Global Campaign to find all children with Progeria. 2010.
7. El Maataoui H, Fahi A, Oukache B. "Sickle cell trait and haemophilia: a rare association". Pan Afr Med J 2018;29:92.
8. NIH - Genetics Home Reference. What is the prognosis of a genetic condition? Available at: <https://ghr.nlm.nih.gov/primer/consult/prognosis>. Accessed 12 November 2020.
9. WHO. Haematopoietic Stem Cell Transplantation. Available at: <https://www.who.int/transplantation/hscx/en/>. Accessed 12 November 2020.
10. Tiercy J. Haematologica 2016;101:680-687.
11. NIH - Genetics Home Reference. What is gene therapy? Available at: <https://ghr.nlm.nih.gov/primer/therapy/genetherapy>. Accessed 12 November 2020.
12. Goswami R et al. Front Oncol 2019;9:297.
13. Maeder ML, Gersbach CA. Mol Ther 2016;24:430-446.
14. EMA. Advanced therapy medicinal products: Overview. 2020. Available at: <https://www.ema.europa.eu/en/human-regulatory/overview/advanced-therapy-medical-products-overview>. Accessed 16 December 2020.
15. Cell and Gene Therapy Catapult. The Cell and Gene Therapy Catapult UK clinical trials database. 2019. Available at: <https://ct.catapult.org.uk/clinical-trials-database>. Accessed 18 November 2020.
16. Cell and Gene Therapy Catapult. Annual Review 2020. Available at: https://fr.zone-secure.net/-/Catapult_CGT_Annual_Review_2020/-/#page=4. Accessed 14 December 2020.