The Genetics of Some Rarer Forms of Spinal Muscular Atrophy

**Spinal Muscular Atrophy** (SMA) is the name given to a number of genetically distinct conditions with similar symptoms. They all result in muscle weakness but there is great variation in the severity and impact they can have.

SMA is passed from parents to their children through their **genes** making it a **hereditary** condition. Many families want to learn more about the **genetics** that have led to SMA in their family. They want to have a better understanding of the condition and what it means for future pregnancies.

This leaflet brings together the limited information available about the following rarer forms of SMA:

- Distal Spinal Muscular Atrophy type V (DSMA-V)
- Spinal and Bulbar Muscular Atrophy (SBMA) - also known as Kennedy’s Disease
- Spinal Muscular Atrophy with Lower Extremity Predominance (SMA-LED)
- Spinal Muscular Atrophy with Progressive Myoclonic Epilepsy (SMA-PME)
- X-linked Infantile Spinal Muscular Atrophy

We hope that it will be useful for individuals, their families, healthcare and other professionals. The glossary at the end of this leaflet explains the words in bold font.

Though the information in this leaflet is as up-to-date and accurate as possible, it is a general summary only. The genetics of any form of SMA is complex and every person with SMA is different. Also, there is a small number of people whose SMA genetics are not clear. If this applies to you then you may need to access further testing and support from clinicians and geneticists.

Your medical team will always be happy to go over any of this information with you. They can provide you with genetic information that applies to your individual situation.
What are genetic conditions?

Genetic conditions are caused by faults in our genes.

Our bodies are made up of many millions of cells. Nearly all cells have a structure called the nucleus, which contains chromosomes.

Body cells usually have two copies of each chromosome – one inherited from a person’s mother and the other one from a person’s father.

We all have 46 chromosomes in each cell in our body and these are arranged in 23 pairs.

Chromosomes are compact bundles of DNA. (See Box 1 for an explanation of DNA.)

A gene is a specific section of DNA. Genes are packaged into chromosomes.

Genes carry the information needed to make proteins. Our cells need protein for their structure, survival and to work correctly. We each have approximately 20,000 different genes making different proteins in our bodies. Each protein made by a different gene has its own unique function. The function is determined by the order in which the base pairs are arranged in that particular gene. Usually there are two copies of each gene on each chromosome pair: one inherited from each parent.

Sometimes a gene can contain an unusual change or fault known as a mutation. Genetic conditions occur when a mutation within a gene affects how the protein in our bodies is produced and how it works.
Box 1 – an explanation of DNA

DNA is often described as a recipe book, or a set of instructions, because it contains the information needed for a person to grow and develop.

DNA is made up of lots of **nucleotides** joined together. Each nucleotide contains a phosphate, a sugar and a base. The phosphate and sugar are always the same but the base varies in each nucleotide. The base can be one of four: adenine (A), guanine (G), cytosine (C), or thymine (T).

These bases pair up: A with T, C with G. The order in which these pairs of bases are arranged affects how the ‘recipe book’ information is read. The joined base pairs hold the nucleotides together in strands that twist together to form the DNA double-helix shape.
Rarer forms of SMA

In the following table you will find:

- The name of the rarer form of SMA and a website link for more information
- The name of the relevant genes and a website link for more information
- The name of the inheritance pattern. (Inheritance patterns are explained after the table)

Please note:

Some of the genes listed in the table are associated with more than one condition so the website links might provide information that is not just about SMA.

The links in the table are to the US National Library of Medicine, Genetics Home Reference. They advise that the resources on their site should not be used as a substitute for professional medical advice.
<table>
<thead>
<tr>
<th>Form of SMA</th>
<th>Relevant Gene</th>
<th>Inheritance Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distal Spinal Muscular Atrophy type V (DMSA-V)</td>
<td>BSCL2 or GARS</td>
<td>Autosomal Dominant</td>
</tr>
<tr>
<td>Spinal and Bulbar Muscular Atrophy - (SBMA, also known as Kennedy’s Disease)</td>
<td>AR (X sex chromosome)</td>
<td>X-linked Recessive</td>
</tr>
<tr>
<td>SMA with Lower Extremity Predominance (SMA-LED)</td>
<td>DYNC1H1</td>
<td>Autosomal Dominant</td>
</tr>
<tr>
<td>Spinal Muscular Atrophy with Progressive Myoclonic Epilepsy (SMA-PME)</td>
<td>ASAH1</td>
<td>Autosomal Recessive</td>
</tr>
<tr>
<td>X-linked Infantile Spinal Muscular Atrophy</td>
<td>UBA1 (X sex chromosome)</td>
<td>X-linked Recessive</td>
</tr>
</tbody>
</table>
Inheritance Patterns Explained

Autosomal dominant

This is the inheritance pattern most often seen in Distal Spinal Muscular Atrophy type V (DSMA-V) and Spinal Muscular Atrophy with Lower Extremity Predominance (SMA-LED).

**Autosomal** dominant inheritance is where having a single faulty copy of a gene is enough to cause the condition, even though a healthy copy of the gene is also present. This means that parents with the condition can pass it directly to their children.

The following diagrams show what the chances are of parents passing on their rare form of SMA to their children if the inheritance pattern is autosomal dominant.

**Autosomal dominant family 1: One parent has SMA and the other does not**

For each pregnancy, if one parent has SMA and the other does not, the chances of each of their children inheriting the condition are as follows:

- **Child has SMA:** 2 in 4 chance (50%)
- **Child does not have SMA:** 2 in 4 chance (50%)
Autosomal dominant family 2: Both parents have SMA

If both parents have SMA and their child inherits two dominant genes, one from each parent, this can cause a very severe form of SMA and possibly other difficulties for the child as well.

For each pregnancy, if both parents have SMA, the chances of each of their children inheriting the condition are as follows:

- Child has SMA: 3 in 4 chance (75%)
- Child does not have SMA: 1 in 4 chance (25%)

Autosomal recessive

This is the inheritance pattern most often seen in Spinal Muscular Atrophy with Progressive Myoclonic Epilepsy (SMA-PME).

In an autosomal recessive pattern of inheritance both copies of the gene must be faulty for the condition to occur. People who have one healthy copy and one faulty copy of a gene do not usually have any symptoms, but the faulty gene can be passed on to their children. As a result of this they are called carriers.

The chances of children being carriers or having a rare form of SMA will depend on whether their parents have the condition or are carriers. The chances stay the same for each pregnancy.

The following diagrams show what the chances are of parents passing on their rare form of SMA to their children if the inheritance pattern is autosomal recessive.

For the purpose of the diagram a ‘non-carrier’ means a person who does not carry the faulty gene and does not have a rare form of SMA.
Autosomal recessive family 1: Both parents are carriers

For each pregnancy, if two carriers have a child together, the chances of each of their children inheriting the condition are as follows:

- Child has SMA: 1 in 4 chance (25%)
- Child does not have SMA but is a carrier: 2 in 4 chance (50%)
- Child does not have SMA and is not a carrier: 1 in 4 chance (25%)

Autosomal recessive family 2: One parent is a carrier, the other does not have SMA and is a non-carrier

For each pregnancy, if one parent is a carrier and the other does not have SMA and is not a carrier, the chances of each of their children inheriting the condition are as follows:

- Child has SMA: not possible (0%)
- Child does not have SMA but is a carrier: 2 in 4 chance (50%)
- Child does not have SMA and is not a carrier: 2 in 4 chance (50%)
Autosomal recessive family 3: One parent has SMA, the other does not have SMA and is a non-carrier

For each pregnancy, if one parent has SMA and the other does not and is not a carrier, the chances of each of their children inheriting the condition are as follows:

- Child has SMA: not possible (0%)
- Child does not have SMA and is not a carrier: not possible (0%)
- Child does not have SMA but is a carrier: 4 in 4 chance (100%)

Autosomal recessive family 4: One parent has SMA, the other is a carrier

For each pregnancy, if one parent has SMA and the other is a carrier, the chances of each of their children inheriting the condition are as follows:

- Child does not have SMA and is not a carrier: not possible (0%)
- Child has SMA: 2 in 4 chance (50%)
- Child does not have SMA but is a carrier: 2 in 4 chance (50%)
Autosomal recessive family 5: Both parents have SMA

For each pregnancy, if both parents have SMA, the chances of each of their children inheriting the condition are as follows:

- All the children will have SMA: 4 in 4 chance (100%)

X-linked recessive

This is the inheritance pattern most often seen in Spinal and Bulbar Muscular Atrophy (SBMA) and X-linked Infantile Spinal Muscular Atrophy.

In an X-linked recessive pattern of inheritance, the faulty gene is on the X chromosome, but is not found on the shorter, male-specific Y chromosome. Males only have one X chromosome and therefore only one copy of the gene. This means that if they have one faulty copy then they have no other healthy copy. Males are therefore much more frequently affected by X-linked disorders than females. Females with one healthy copy and one faulty copy of the gene do not usually have any symptoms, although some have a very mild form of the condition. But, the faulty gene can be passed on to their children. As a result of this they are called carriers.

The chances of children being carriers or having a rare form of SMA will depend on whether their parents have the condition or are carriers. The chances stay the same for each pregnancy.

The following diagrams show what the chances are of parents passing on their rare form of SMA to their children if the inheritance pattern is X-linked recessive.

For the purpose of the diagram a ‘non-carrier’ means a person who does not carry the faulty gene and does not have a rare form of SMA.
**X-linked recessive family 1: The mother is a carrier, the father is not a carrier and does not have SMA**

For each pregnancy, if the mother is a carrier and the father is not a carrier and does not have the condition, the chances of each of their children inheriting the condition are as follows:

- Daughters have a 1 in 2 chance (50%) of not having SMA and not being a carrier
- Sons have a 1 in 2 chance (50%) of not having SMA and not being a carrier
- Daughters have a 1 in 2 chance (50%) of being a carrier
- Sons have a 1 in 2 chance (50%) of having SMA

**X-linked recessive family 2: The mother is a carrier, the father has SMA**

For each pregnancy, if the mother is a carrier and the father has SMA, the chances of each of their children inheriting the condition are as follows:

- Daughters have a 1 in 2 chance (50%) of being a carrier
- Sons have a 1 in 2 chance of not having SMA and not being a carrier
- Daughters have a 1 in 2 chance (50%) of having SMA
- Sons have a 1 in 2 chance (50%) of having SMA
**X-linked recessive family 3: The mother does not have SMA and is not a carrier, the father has SMA**

For each pregnancy, if the mother does not have SMA and is not a carrier and the father has SMA, the chances of each of their children inheriting the condition are as follows:

- Daughters have a 2 in 2 chance (100%) of being a carrier
- Sons have a 2 in 2 chance (100%) of not having SMA and not being a carrier

**X-linked recessive family 4: The mother has SMA, the father does not have SMA and is not a carrier**

For each pregnancy, if the mother has SMA and the father does not have SMA and is not a carrier, the chances of each of their children inheriting the condition are as follows:

- Daughters have a 2 in 2 chance (100%) of being a carrier
- Sons have a 2 in 2 chance (100%) of having SMA
**X-linked recessive family 5: Both parents have SMA**

For each pregnancy, if both parents have SMA, the chances of each of their children inheriting the condition are as follows:

- All the children will have SMA

**Is SMA always inherited from one or both parents?**

In some cases, the genetic change responsible for SMA may not be present in either parent. In other words, it may be a new gene change in the affected individual (called a *de novo* mutation). In this situation, the chance of a future pregnancy being affected by SMA is usually low. However, if you have questions about the implications of a diagnosis of SMA for future pregnancies, it is important to request a referral for genetic counselling in order to obtain the most accurate advice specific to your situation.

**What is genetic counselling?**

If you have a child with a rarer form of SMA, or are a newly diagnosed adult with a rarer form of SMA, you should be offered a referral for genetic counselling. You can also request a referral from your General Practitioner (G.P.).

Genetic counselling takes place with a healthcare professional who has expert training in genetics. They will answer any questions you have regarding your genetic circumstances and they will provide you with advice and information. You will be able to go back to them at a later date if you have more questions.
How can we find out if our future children will have a rare form of SMA?

If a genetic test is available, one option is prenatal diagnosis. For example, amniocentesis and chorionic villus sampling (CVS) in which the foetus is genetically tested to see if it has SMA. If it does, you as a couple will have the opportunity to decide whether or not to continue with the pregnancy.

If a genetic test is available, another option may be pre-implantation genetic diagnosis (PGD). This involves collecting eggs from the woman and fertilising them outside the body (similar to IVF treatment). Each embryo is tested and only embryos that are carriers or do not have SMA are implanted back into the uterus.

As a couple you will want to make a joint personal decision about these options and the healthcare professionals who see you will give you more information to help with this. You can also read SMA Support UK’s information sheet Future Options in Pregnancy: http://www.smasupportuk.org.uk/future-options-in-pregnancy

Further information and resources

Genetics and Genetic Testing

Cure SMA (America) www.curesma.org/sma/causes-diagnoses/genetics/  
(formerly Families of SMA)

Genetic Alliance UK www.geneticalliance.org.uk/publications_patients.htm  
Tel: 0207 704 3141

The UK SMA Patient Registry

At the moment the UK SMA Patient Registry does not cover any of the rarer forms of SMA listed in this leaflet, but for information about the work of the Registry and to see what their plans are for the future please visit their website: www.treat-nmd.org.uk/registry

The registry can also be contacted on: 0191 241 8617
SMA Support UK Information

SMA Support UK supports people affected by any form of SMA. You can contact us for information, support, mailings, and to join in with our social activities. Phone 01789 267 520 or email supportservices@smasupportuk.org.uk

Paper copies of the following leaflets can be obtained by contacting SMA Support UK or you can download them from our website: www.smasupportuk.org.uk

- The Genetics of Spinal Muscular Atrophy
- Spinal Muscular Atrophy – Information for Families
- Adult Onset Spinal Muscular Atrophy
- Spinal Muscular Atrophy with Respiratory Distress (SMARD)
- Future Options in Pregnancy
- Who’s Who of Professionals
Glossary of Terms

Amino acid
The individual building blocks of proteins. There are 20 different amino acids that are naturally incorporated into proteins. The specific order of the amino acids determines the structure and function of a protein.

Amniocentesis
The removal of a sample of amniotic fluid (the fluid around an unborn baby) for prenatal testing. Cells in the fluid can be tested for certain genetic disorders.

Amniotic fluid
The fluid surrounding a foetus in the womb.

Anterior Horn
The front part of the spinal cord where the cell bodies of the lower motor neurons are located. Long, slender projections of the motor neurons called axons migrate out from the anterior horn in large bundles of nerves in order to reach muscles.

Anterior Horn Cell
The nerve cells that make up the anterior horn of the spinal cord. Also known as lower motor neurons, these cells are the main cell type affected in SMA.

Antibodies
Proteins made by the body to protect itself from “foreign” substances such as bacteria or viruses.

Atrophy
The wasting or shrinkage of a part of the body. SMA is called Spinal Muscular Atrophy because the lower motor neurons within the spinal cord degenerate, which leads to the wasting of skeletal muscles.

Autosomal inheritance
Inheritance of a faulty gene on one of the autosomes - the chromosomes other than the sex chromosomes. Autosomal inheritance usually affects both males and females equally.

Autosomal recessive inheritance
When a genetic disorder is recessive, two faulty copies of a gene, one from each parent, must come together for the disease to occur. If a person has only one faulty copy, they do not usually have the symptoms of the disease, but are known as carriers because they can pass on the faulty gene to their children. A disease is autosomal when the faulty gene is found on one of the autosomes. SMA is usually an autosomal recessive condition.
Autosome
Any of the 22 pairs of chromosomes found in the human body that are not involved in the determination of sex. They are identical in both males and females. Each pair of autosomes (one from the father, one from the mother) contain genes for the same traits (characteristics).

Axon
The long, slender main projections of a nerve cell. Axons carry electrical impulses away from the cell body (where the nucleus is) to its target, such as muscles.

Carrier
This term relates to autosomal recessive inheritance and X-linked recessive inheritance patterns. A person who has both a faulty copy and a healthy copy of a gene is a carrier. Carriers usually have no symptoms due to the healthy copy of the gene, but they may pass on a condition to their children. In the case of SMA, carriers have one faulty copy of the Survival Motor Neuron 1 (SMN1) gene and one healthy copy of SMN1. Two individuals who each carry the SMN1 mutation have a 25% (1 in 4) chance of having a child with SMA for each pregnancy. A child must inherit two copies of the faulty SMN1 gene to develop SMA, one copy from each parent.

Carrier testing
A genetic test to find out if a person is a carrier of a faulty gene.

Cell
The basic building block of all known living organisms. Cells come in many different forms such as motor neurons (a type of nerve cell), keratinocytes (main cell type of the skin), or erythrocytes (red blood cells).

Central nervous system (CNS)
The central nervous system consists of the brain and the spinal cord. The CNS is connected to other tissues and organs in the body, such as skeletal muscles, by the peripheral nervous system (PNS).

Chorionic villus sampling (CVS)
CVS is a way to test if an unborn baby has SMA. A sample of chorionic villous cells (placental tissue) is removed using a needle. This is usually done between the eleventh and fourteenth week of a pregnancy. The cells can then be genetically tested for SMA.

Chromosomes
Chromosomes are compact bundles of DNA. Humans have 46 chromosomes in each cell (with a few exceptions, including sperm and egg cells). They inherit 23 from their mother and 23 from their father to make 23 pairs.
Clinical
The observation and treatment of patients, rather than laboratory studies that do not directly involve patients.

Clinical trial
A trial done on humans, usually to test a treatment or intervention, or to find out more about a disease.

De novo mutation
An alteration in a gene that arises for the first time in one family member as a result of a mutation in an egg or sperm cell of one of the parents, or in the fertilised egg itself. Neither parent will have the mutation themselves.

Diagnosis
Identifying a disease from its signs and symptoms or from its genetic cause. A clinical diagnosis is given when a doctor sees enough signs or symptoms to be confident that a person has the disease in question. In genetic disorders, a genetic diagnosis is given when a genetic test has been performed and the fault in the gene that is known to cause the disease is found. Doctors who are experts in SMA can usually diagnose the condition with a high degree of accuracy from the clinical signs and symptoms alone. However, genetic tests are usually recommended for all genetic disorders to increase certainty, to make sure any treatment is correctly targeted and to enable the family to have prenatal testing in future pregnancies if they wish.

DNA (Deoxyribonucleic acid)
DNA is the molecule that contains the genetic instruction manual to build all known organisms. DNA is often compared to a set of blueprints, a recipe, or a code, since it contains the instructions needed to construct other components of cells, such as proteins.

Embryo
The name given to the developmental stage from fertilised egg up until about eight weeks of pregnancy when the embryo becomes a foetus.

Enzyme
A protein which initiates, facilitates or speeds up a chemical reaction. Almost all of the processes that occur in our body require enzymes. Examples include the digestion of food and the growth and building of cells.

Exon
Genes are divided into regions called exons and introns. Exons are the sections of DNA that provide the code that enables proteins to be produced.
**Foetus (fetus)**
The term used for an unborn baby after the eighth week of development until birth.

**Gene**
A section of DNA that carries the information to produce a specific protein. Genes are the unit of heredity that are passed from one generation to the next. We usually possess two copies of each gene, one inherited from each of our parents. When genes are altered through mutation, this can affect the structure and function of the proteins that they produce, leading to disease.

**Genetic counselling**
Information and support provided by a genetic specialist to people who have genetic disorders in their families or are concerned about a genetically transmitted condition. Genetic counselling helps families understand things like how the condition is passed on, what the chances are of children being affected, and which other family members may be at risk of carrying the affected gene. It also helps affected teenagers / young adults to understand their future choices.

**Genetic disorders**
Conditions resulting from alterations to an individual’s genes. Genetic disorders can be caused by defects in one or more genes, or whole chromosomes.

**Genetic testing**
The examination of an individual’s genes to identify any faults that could cause a genetic disorder.

**Genetics**
The study of genes and inheritance.

**Heredity**
The passing of traits (characteristics) through the inheritance of genes from one generation to the next.

**Inheritance**
The process by which an individual acquires traits (characteristics) from his or her parents.

**Intron**
Genes are divided into regions called exons and introns. The protein-coding exons are interspersed with introns, which have structural and regulatory roles.
**In vitro fertilisation (IVF)**

A process by which eggs are fertilised by sperm outside the womb. The fertilised egg is then transferred into the womb to try to establish a successful pregnancy.

**Messenger RNA (mRNA)**

An intermediate molecule between DNA and proteins. It acts as a template that can be read by the ribosomes in order to produce proteins.

**Molecule**

Two or more atoms chemically bonded together. For example, water is a molecule made up of two hydrogen atoms and one oxygen atom bonded together (H₂O).

**Motor neurons**

The nerve cells that connect the brain and spinal cord to skeletal muscles allowing conscious muscle contraction (movement). They act as a message delivery system: electrical signals originating in the brain are fired down the spinal cord along upper motor neurons; the electrical signals continue along lower motor neurons, which project out to skeletal muscles to control movement. Lower motor neurons are located in the anterior horn of the spinal cord and are the main cell type affected by SMA. In SMA, low levels of the Survival Motor Neuron (SMN) protein cause the deterioration of lower motor neurons leading to muscle weakness and atrophy.

**Mutation**

A permanent change in the DNA sequence of a gene that can be inherited by subsequent generations. Dependent upon the type of mutation and where it occurs within the gene, it might have no effect on the protein produced, or it might disturb the protein’s function causing a genetic disorder such as SMA.

**Nerve Cells**

Also called neurons, nerve cells allow the quick transmission of electrical signals throughout the body. Different types of nerve cell make up the nervous system which functions to allow us to perceive and react to our surroundings. For example, the brain sends a signal along the nerves to tell a muscle to contract (move). Nerve cells are important for both involuntary (unconscious) functions like the beating of the heart and voluntary (conscious) functions like moving your arm.

**Nucleotide**

The individual building block of our DNA and RNA. A nucleotide consists of a base, one of four chemicals: adenine (A), cytosine (C), guanine (G) and thymine (T), plus a molecule of sugar and one of phosphoric acid. Within DNA, A pairs with T, and C with G. Within RNA the thymine is replaced by uracil (U).
Nucleus
The control centre of a cell that contains the DNA wrapped up within chromosomes.

Peripheral nervous system (PNS)
Consists of the nerve cell extensions found outside of the central nervous system (CNS). The PNS acts to connect the CNS with the muscles and internal organs. The lower motor neuron axons and their connections with the muscle are found within the PNS.

Pre-implantation genetic diagnosis (PGD)
The technique used to test very early embryos for a specific genetic disorder before they are implanted into the womb. Couples undergo standard in vitro fertilisation (IVF) during which eggs are fertilised by sperm outside the womb. The embryos are grown in the laboratory until they have grown into a ball of cells. A small sample of these cells is then removed for genetic testing.

Prenatal testing
The genetic testing for diseases or conditions in a foetus or embryo. This is done by removing a sample of fluid or tissue by procedures such as amniocentesis or chorionic villus sampling (CVS).

Protein
Proteins consist of chains of amino acids arranged in very specific orders. The order of amino acids within a chain is determined by the genetic code (DNA). Different genes have the “instructions” for making different proteins. Proteins are the building blocks of our bodies and are essential for the structure, function, and regulation of cells, tissues and organs. Examples of different proteins include enzymes, hormones, antibodies and the survival motor neuron (SMN) protein.

Recessive
Autosomal recessive describes a form of inheritance in which two faulty copies of a gene are required in order for a person to be affected by a genetic disorder. This means that a faulty copy of a gene is inherited from each parent. Survival Motor Neuron 1-associated SMA is an autosomal recessive condition. In X-linked recessive conditions, two faulty copies of the gene are needed for the genetic disorder to show in females, but only one faulty copy in males. This is because X-linked recessive conditions are caused by mutations in genes found on the X chromosome, but that are missing from the Y chromosome. Males have one X and one Y chromosome, while females have two X chromosomes.

Ribosome
Ribosomes read messenger RNA (mRNA) and use it as a template to build proteins within a cell by connecting amino acids together.
RNA (ribonucleic acid)
RNA is very similar to DNA in that it carries genetic information. It plays an important role in the creation of proteins. There are different types of RNA that have different roles, for example messenger RNA (mRNA).

Sex chromosomes
The X and Y chromosomes determine the sex of an individual. Females have two X chromosomes; males have an X and a Y chromosome.

Skeletal muscle
Consciously controlled muscle that attaches to bones allowing movement. Examples include the biceps, triceps, and thigh muscles.

Spinal
Relating to the spine.

Spinal cord
The bundle of nervous tissue within the spine. It includes nerve cells and extends out from the brain. The brain and spinal cord make up the central nervous system (CNS).

Survival Motor Neuron 1 (SMN1)
The gene that when mutated or deleted can lead to the development of SMA. For our lower motor neurons to survive and thrive we need a certain amount of the full-length SMN protein produced by the SMN1 gene.

Survival Motor Neuron 2 (SMN2)
The gene that can have an impact on the severity of SMA because it is able to produce a small amount of functional SMN protein. In people with a fault in the SMN1 gene, this can be important because the more copies of SMN2 that someone has, the more functional SMN protein they can produce. Individuals with more severe forms of SMA, for example Types 1 and 2, usually have fewer copies of the SMN2 gene than those with SMA Type 3.

Survival Motor Neuron (SMN) gene
A gene that produces the Survival Motor Neuron protein. Mutations in the SMN1 gene are the cause of some forms of SMA. There are two types of SMN genes - SMN1 and SMN2.

Survival Motor Neuron (SMN) protein
Produced from both the SMN1 and SMN2 genes, the SMN protein is required for the survival of lower motor neurons. If there is no SMN protein in a cell, the cell will die. Of all
the different cell types, the lower motor neurons seem to be most affected by low levels of SMN protein.

**Tissue**

A collection of cells that work together to perform a common function. For example, organs are formed from multiple tissues.

**Virus**

Viruses consist of genetic material (DNA or RNA) surrounded by a protective coat of protein. They are capable of latching onto cells and getting inside them. Some viruses (like the cold virus or flu virus) cause people to become ill. But, their ability to get inside cells also means that certain viruses can be used to deliver treatments into the cell.


References


We are grateful to the writers and reviewers who assist us in our information production. A list of who this includes may be viewed on our website: www.smasupportuk.org.uk/our-writers-and-reviewers-panel or requested from supportservices@smasupportuk.org.uk

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