FUS Gene

Subjects: Genetics & Heredity
Contributor: Vivi Li

FUS RNA binding protein

Keywords: genes

1. Normal Function

The *FUS* gene provides instructions for making a protein that is found within the cell nucleus in most tissues and is involved in many of the steps of protein production.

The FUS protein attaches (binds) to DNA and regulates an activity called transcription, which is the first step in the production of proteins from genes. The FUS protein is also involved in processing molecules called messenger RNA (mRNA), which serve as the genetic blueprints for making proteins. By cutting and rearranging mRNA molecules in different ways, the FUS protein controls the production of different versions of certain proteins. This process is known as alternative splicing. Once the FUS protein processes the mRNA, it transports the mRNA out of the nucleus where it gets taken up by other cell structures to be further processed into a mature protein. The FUS protein also helps repair errors in DNA, which prevents cells from accumulating genetic damage.

2. Health Conditions Related to Genetic Changes

2.1 Amyotrophic Lateral Sclerosis

At least 85 mutations in the *FUS* gene have been found to cause amyotrophic lateral sclerosis (ALS), a condition characterized by progressive muscle weakness, a loss of muscle mass, and an inability to control movement. Most of these mutations change single protein building blocks in the FUS protein and often affect the region of the protein involved in DNA binding and mRNA processing. These mutations may interfere with the transport of mRNA out of the nucleus of cells. As a result, FUS protein and mRNA are trapped within cells and likely form clumps (aggregates), which have been found in nerve cells that control muscle movement (motor neurons) in some people with ALS. It is unclear if protein aggregates cause the nerve cell death that leads to ALS. People with ALS caused by mutations in the *FUS* gene tend to develop the disease at a younger age and have a decreased life expectancy compared with individuals who have sporadic ALS or ALS caused by mutations in other genes.

Rarely, people with ALS caused by *FUS* gene mutations also develop a condition called frontotemporal dementia (FTD), which is a progressive brain disorder that affects personality, behavior, and language. It is unclear why some people with *FUS* gene mutations develop FTD and others do not. Individuals who develop both conditions are diagnosed as having ALS-FTD.

2.2 Ewing Sarcoma

2.3 Cancers

Specific mutations involving the *FUS* gene are involved in several types of cancer. The mutations that cause these tumors are acquired during a person's lifetime and are present only in the tumor cells. This type of genetic change, called a somatic mutation, is not inherited. Most commonly, mutations in this gene are found in tumors called soft tissue sarcomas, which develop in bones or in soft tissues such as nerves or cartilage. *FUS* gene mutations have also been found in myxoid liposarcomas, which occur in fatty tissues of the body, and in cancer of the blood-forming cells in the bone marrow called acute myeloid leukemia (AML). The genetic changes associated with these cancers are rearrangements (translocations) of genetic material between chromosome 16 (where the *FUS* gene is located) and other chromosomes. These translocations break chromosome 16 in the middle of the *FUS* gene and fuse it with another gene on a different

chromosome, creating a fusion gene. Fusion genes usually have partial function of both genes involved. The *FUS* gene promotes DNA transcription and protein production, which helps promote cell growth; this gene might fuse with another gene that could allow cell growth to continue at a rapid pace. When cell growth is left uncontrolled, cancer can develop.

3. Other Names for This Gene

- ALS6
- ETM4
- FUS1
- FUS_HUMAN
- fused in sarcoma
- heterogeneous nuclear ribonucleoprotein P2
- hnRNP-P2
- HNRNPP2
- oncogene FUS
- oncogene TLS
- POMP75
- RNA-binding protein FUS
- TLS
- translocated in liposarcoma protein

References

1. Coady TH, Manley JL. ALS mutations in TLS/FUS disrupt target gene expression. Genes Dev. 2015 Aug 15;29(16):1696-706. doi: 10.1101/gad.267286.115.
2. Crozat A, Aman P, Mandahl N, Ron D. Fusion of CHOP to a novel RNA-bindingprotein in human myxoid liposarcoma. Nature. 1993 Jun 17;363(6430):640-4.
3. Deng H, Gao K, Jankovic J. The role of FUS gene variants in neurodegenerative diseases. Nat Rev Neurol. 2014 Jun;10(6):337-48. doi: 10.1038/nrneurol.2014.78.
4. Hewitt C, Kirby J, Highley JR, Hartley JA, Hibberd R, Hollinger HC, WilliamsTL, Ince PG, McDermott CJ, Shaw PJ. Novel FUS/TLS mutations and pathology infamilial and sporadic amyotrophic lateral sclerosis. Arch Neurol. 2010Apr;67(4):455-61. doi: 10.1001/archneurol.2010.52.
5. Panagopoulos I, Storlazzi CT, Fletcher CD, Fletcher JA, Nascimento A, DomanskiHA, Wejde J, Brosjö O, Rydholm A, Isaksson M, Mandahl N, Mertens F. The chimeric FUS/CREB3l2 gene is specific for low-grade fibromyxoid sarcoma. Genes ChromosomesCancer. 2004 Jul;40(3):218-28.
6. Schwartz JC, Podell ER, Han SS, Berry JD, Eggan KC, Cech TR. FUS issequestered in nuclear aggregates in ALS patient fibroblasts. Mol Biol Cell. 2014Sep 1;25(17):2571-8. doi: 10.1091/mbc.E14-05-1007.
7. Storlazzi CT, Mertens F, Nascimento A, Isaksson M, Wejde J, Brosjo O, Mandahl N, Panagopoulos I. Fusion of the FUS and BBF2H7 genes in low grade fibromyxoidsarcoma. Hum Mol Genet. 2003 Sep 15;12(18):2349-58.
8. Vance C, Rogelj B, Hortobágyi T, De Vos KJ, Nishimura AL, Sreedharan J, Hu X, Smith B, Ruddy D, Wright P, Ganesalingam J, Williams KL, Tripathi V, Al-Saraj S, Al-Chalabi A, Leigh PN, Blair IP, Nicholson G, de Belleroche J, Gallo JM, Miller CC, Shaw CE. Mutations in FUS, an RNA processing protein, cause familialamyotrophic lateral sclerosis type 6. Science. 2009 Feb 27;323(5918):1208-1211.doi: 10.1126/science.1165942.
9. Wang X, Arai S, Song X, Reichart D, Du K, Pascual G, Tempst P, Rosenfeld MG,Glass CK, Kurokawa R. Induced ncRNAs allosterically modify RNA-binding proteinsin cis to inhibit transcription. Nature. 2008 Jul 3;454(7200):126-30. doi:10.1038/nature06992.