COL7A1 gene
collagen type VII alpha 1 chain

Normal Function

The \textit{COL7A1} gene provides instructions for making a protein called pro-\(\alpha\)1(VII) chain that is used to assemble a larger protein called type VII collagen. Collagens are a family of proteins that strengthen and support connective tissues, such as skin, bone, tendons, and ligaments, throughout the body. In particular, type VII collagen plays an essential role in strengthening and stabilizing the skin.

Three pro-\(\alpha\)1(VII) chains twist together to form a triple-stranded, ropelike molecule known as a procollagen. Cells release (secrete) procollagen molecules, and enzymes cut extra protein segments from the ends. Then the molecules arrange themselves into long, thin bundles of mature type VII collagen.

Type VII collagen is the major component of structures in the skin called anchoring fibrils. These fibrils are found in a region known as the epidermal basement membrane zone, which is a two-layer membrane located between the top layer of skin, called the epidermis, and an underlying layer called the dermis. Anchoring fibrils hold the two layers of skin together by connecting the epidermal basement membrane to the dermis.

Health Conditions Related to Genetic Changes

\textbf{Dystrophic epidermolysis bullosa}

More than 700 mutations in the \textit{COL7A1} gene have been identified in people with dystrophic epidermolysis bullosa, a condition that causes the skin to be very fragile and to blister easily. These mutations alter the structure or disrupt the production of the pro-\(\alpha\)1(VII) chain protein, which affects the production of type VII collagen. When type VII collagen is abnormal or missing, anchoring fibrils cannot form properly. A shortage of these fibrils impairs the connection of the epidermis to the dermis. As a result, friction or other minor trauma can cause the two skin layers to separate. This separation leads to the formation of blisters, which can result in extensive scarring as they heal.

Researchers classify dystrophic epidermolysis bullosa into a few major types based on the inheritance pattern and features of the condition. The recessive types of dystrophic epidermolysis bullosa (RDEB) result from mutations in both copies of the \textit{COL7A1} gene in each cell. The most severe, classic form of this disorder is known as recessive dystrophic epidermolysis bullosa severe generalized (RDEB-sev gen). Most of the \textit{COL7A1} gene mutations responsible for RDEB-sev gen result in production of abnormally short pro-\(\alpha\)1(VII) chains that cannot form type VII collagen. As a result,
little type VII collagen is available to make anchoring fibrils. This lack of anchoring fibrils disrupts the connection between the epidermis and the dermis and causes the extreme skin fragility and other signs and symptoms of RDEB-sev gen.

Somewhat less severe forms of RDEB, grouped as the generalized and localized types (RDEB-gen and -loc), are caused by other types of mutations. Many of these genetic changes alter the structure of the pro-α1(VII) chain protein such that it cannot form normal type VII collagen. As a result, anchoring fibrils are reduced in number, or they are altered and cannot function normally. The small amount of normal or partially functional anchoring fibrils accounts for the less severe signs and symptoms of RDEB-gen and -loc.

A milder, dominant form of dystrophic epidermolysis bullosa (DDEB) results from mutations in one copy of the COL7A1 gene in each cell. In many cases, these mutations alter a part of type VII collagen known as the triple helical domain. This region gives type VII collagen its usual triple-stranded structure. It is made up of a pattern of protein building blocks (amino acids) in which every third amino acid is a glycine. Mutations that substitute other amino acids for glycine in this region can disrupt the triple-stranded structure of type VII collagen. When the abnormally shaped collagen molecules are incorporated into anchoring fibrils, they interfere with the fibrils’ normal function and prevent them from effectively connecting the epidermis and the dermis. Although they are most commonly associated with DDEB, mutations that substitute glycine amino acids in the triple helical domain can also cause RDEB. DDEB can also be caused by other types of mutations, particularly changes that affect the folding of type VII collagen.

It is unclear how COL7A1 gene mutations are associated with an increased risk of a certain cancer called squamous cell carcinoma in people with dystrophic epidermolysis bullosa, particularly RDEB-sev gen. Some research has suggested that abnormal forms of type VII collagen that retain a procollagen fragment called the NC1 domain may increase the risk of tumor formation. Other studies, however, have not found this association.

Other disorders

Mutations in the COL7A1 gene can also cause a rare condition called epidermolysis bullosa with congenital localized absence of skin (also known as Bart syndrome or aplasia cutis congenita type VI). Individuals with this condition have patches of missing skin at birth (aplasia cutis congenita), typically on the legs. On other parts of the body, they have the characteristic skin problems of epidermolysis bullosa. Epidermolysis bullosa is a group of conditions that cause the skin to be very fragile and to blister easily. Abnormal or absent fingernails and toenails are also common in people with epidermolysis bullosa with congenital localized absence of skin.

As in dystrophic epidermolysis bullosa (described above), COL7A1 gene mutations impair the formation of functional anchoring fibrils. A shortage of these fibrils results in skin fragility and blistering.
Some doctors believe that the aplasia cutis congenita arises from skin fragility and blisters during birth and does not signify a condition separate from epidermolysis bullosa. It is unclear why some newborns have this feature and others do not.

**Chromosomal Location**

Cytogenetic Location: 3p21.31, which is the short (p) arm of chromosome 3 at position 21.31

Molecular Location: base pairs 48,564,073 to 48,595,329 on chromosome 3 (Homo sapiens Updated Annotation Release 109.20200228, GRCh38.p13) (NCBI)

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**Other Names for This Gene**

- alpha 1 type VII collagen
- CO7A1_HUMAN
- collagen type VII alpha 1
- collagen VII, alpha-1 polypeptide
- collagen, type VII, alpha 1
- collagen, type VII, alpha 1 (epidermolysis bullosa, dystrophic, dominant and recessive)
- EBD1
- EBDCT
- EBR1
- LC collagen
- long chain collagen
Additional Information & Resources

Educational Resources

• Molecular Biology of the Cell (fourth edition, 2002): Collagens Are the Major Proteins of the Extracellular Matrix
  https://www.ncbi.nlm.nih.gov/books/NBK26810/#A3551

Clinical Information from GeneReviews

• Dystrophic Epidermolysis Bullosa
  https://www.ncbi.nlm.nih.gov/books/NBK1304

Scientific Articles on PubMed

• PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28COL7A1%5BTIAB%5D%29+AND+%28%28Genes%5BMH%5D%29+OR+%28Genetic+Phenomena%5BMH%5D %29%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last +1800+days%22%5Bdp%5D

Catalog of Genes and Diseases from OMIM

• COLLAGEN, TYPE VII, ALPHA-1
  http://omim.org/entry/120120

Research Resources

• Atlas of Genetics and Cytogenetics in Oncology and Haematology
  http://atlasgeneticsoncology.org/Genes/GC_COL7A1.html

• ClinVar

• HGNC Gene Symbol Report

• Monarch Initiative
  https://monarchinitiative.org/gene/NCBIgene:1294

• NCBI Gene

• UniProt
  https://www.uniprot.org/uniprot/Q02388
Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/21448560

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/10367730

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/29722429

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/17425959

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/12485454

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