The Genetics of Thyroid Cancer

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What are genes?

Genes carry information in the form of DNA within each cell of the human body. Researchers estimate that there are 30,000 different genes in each cell. Genes are packaged onto chromosomes. There are 23 pairs of chromosomes in each cell. One chromosome of each pair is inherited from the person's father and one from the person's mother.

Genes control how a cell functions, including how quickly it grows, how often it divides, and how long it lives. To control these functions, genes produce proteins that perform specific tasks and act as messengers for the cell. Therefore, it is essential that each gene have the correct instructions or "code" for making its protein so that the protein can perform the proper function for the cell.

What role do genes play in thyroid cancer?

Many cancers begin when one or more genes in a cell are mutated (changed), creating an abnormal protein or no protein at all. The information provided by an abnormal protein is different from that of a normal protein, which can cause cells to multiply uncontrollably and become cancerous.

A person may either be born with a genetic mutation in all of their cells (germline mutation) or acquire a genetic mutation in a single cell during his or her lifetime. An acquired mutation is passed on to all cells that develop from that single cell (called a somatic mutation). Somatic mutations can sometimes be caused by environmental factors, such as cigarette smoke. Most thyroid cancers are considered sporadic, meaning that the damage to the genes occurs after a person is born and there is no risk of passing on the gene to a person's children. Inherited thyroid cancers are less common (about 10%) and occur when gene mutations are passed within a family from one generation to the next.

What are the chances a mutated gene is inherited?

Every cell usually has two copies of each gene: one inherited from a person's mother and one inherited from a person's father. Hereditary thyroid cancer usually follows an autosomal dominant inheritance pattern, in which a mutation needs to happen in only one copy of the gene for the person to have an increased risk of getting the disease. This means that a parent with a gene mutation may pass on a copy of the normal gene or a copy of the gene with a mutation. Therefore, a child who has a parent with a mutation has a 50% chance of inheriting that mutation. A brother, sister, or parent of a person who has a gene mutation also has a 50% chance of having the same mutation.

What is a person's average risk for thyroid cancer?

A person with an average risk for thyroid cancer has less than a 1% chance of developing thyroid cancer during his or her life. Women develop thyroid cancer more often than men.

How can a person know if he or she has inherited a genetic mutation that increases his or her risk of thyroid cancer?

Only genetic testing [2] can determine whether a person has a genetic mutation. Most experts strongly recommend that people considering genetic testing first talk with a genetic counselor [3]. Genetic counselors are trained to explain the risks and benefits of genetic testing.

How does a person know if thyroid cancer runs in the family?

The risk of inherited thyroid cancer is low. Thyroid cancer may run in the family if first-degree relatives (parents, brothers, sisters, children) or many close relatives (first-degree relatives, grandparents, aunts, uncles, nieces, nephews, grandchildren, cousins) have been diagnosed with thyroid cancer, especially before age 30.

What is a person's risk if thyroid cancer runs in the family?

If a person's first-degree relatives developed thyroid cancer, his or her risk of thyroid cancer is higher than the average risk. The risk increases if other close relatives have thyroid cancer.

Which inherited genetic mutations raise the risk of thyroid cancer?

There are some genetic conditions associated with an increased risk of thyroid cancer. Some of the most common hereditary cancer syndromes associated with thyroid cancer risk are described below.

Medullary thyroid cancer

Medullary thyroid cancer (MTC) accounts for about 5% of thyroid cancers. Approximately 25% of these are caused by an inherited cancer risk. Three genetic conditions are responsible for hereditary MTC: multiple endocrine neoplasia (MEN) 2A, MEN 2B, and familial medullary thyroid carcinoma (FMTC) [4].

MEN 2A. Families with MEN 2A have an increased risk of developing MTC, as well as pheochromocytoma [5] and noncancerous parathyroid tumors [6]. Or, people in these families may have a larger parathyroid gland.

MEN 2B. People with MEN2B have an increased risk of developing MTC, pheochromocytoma [5], and physical differences, such as a long face and long arms and legs, and thick, lumpy lips caused by noncancerous tumors called mucosal neuromas. Some people with MEN 2B have bowel problems. Signs of MEN 2B, including MTC, can be begin in childhood.

Familial medullary thyroid cancer (FMTC). FMTC is associated with an increased risk of MTC only.

Doctors often recommend that a person who develops MTC be tested for a germline mutation, because he or she might be the first person diagnosed with the tumor in a family with a mutation. Relatives, siblings, and children should then be tested for the mutation.

Papillary and follicular thyroid cancer

Papillary and follicular thyroid cancers make up about 90% of all thyroid cancers. Less than 5% of papillary cancers are thought to be inherited.

Familial papillary thyroid cancer. More research is needed to identify the specific genes associated with papillary thyroid cancer risk. For this reason, genetic testing is not currently available.

Familial adenomatous polyposis (FAP) [7]**.** People with FAP often develop polyps (a growth in the colon or rectum) that are noncancerous at first, but eventually develop into cancer if not treated. FAP is caused by a specific genetic mutation that increases the risk of developing colorectal cancer [8] and other types of cancer, such as stomach [9], small intestine [10], pancreas [11], thyroid, and hepatoblastoma (liver cancer that usually occurs in early childhood). The average age of people with FAP who develop thyroid cancer is 28, and women with FAP appear to have a higher risk than men.

Cowden syndrome (CS) [12]**.** CS is a rare genetic condition caused by a specific genetic mutation. People with CS have an increased risk of developing breast cancer [13] and noncancerous breast changes and noncancerous and cancerous tumors of the thyroid and endometrium [14] (lining of the uterus). Follicular thyroid cancer is more common than papillary thyroid cancer for people with CS. People with CS also often have noncancerous thyroid changes, including multinodular goiter (enlarged thyroid gland with multiple growths or nodules), adenomatous nodules (growths on the thyroid gland), and follicular adenomas (another type of growth on the thyroid gland).

What is your risk level?

In addition to family history, other environmental and lifestyle factors may increase your risk of thyroid cancer. Discussing your family history and personal risk factors with a doctor can help you better understand your risk. People with a higher than average risk may benefit from genetic counseling and early detection strategies.

A risk factor [15] is anything that increases a person's risk of developing cancer. Having a particular genetic mutation linked to thyroid cancer cannot predict that a person will develop cancer. Controllable risk factors, such as eating a balanced diet, maintaining a healthy weight, exercising, avoiding chemicals and asbestos, limiting alcoholic beverages, and avoiding tobacco products also play a role. Many people who develop thyroid cancer have few known risk factors. Research to better understand how genetic mutations cause the development of thyroid cancer and how to prevent this process is ongoing. Talk with a doctor for more information about risk factors, prevention, and screening for thyroid cancer.

More Information

Genetics [16]

Guide to Thyroid Cancer [17]

Sharing Genetic Test Results With Your Family [18]

Direct-to-Consumer Genetic Testing [19]

Links:
[1] http://www.cancer.net/about-us
[2] http://www.cancer.net/node/24895
[3] http://www.cancer.net/node/24907
[4] http://www.cancer.net/node/19365
[5] http://www.cancer.net/node/19437
[6] http://www.cancer.net/node/19509

[7] http://www.cancer.net/node/18852
[8] http://www.cancer.net/node/18701
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