Let's Talk About Biomarkers

When a brain or spinal tumor is biopsied or removed, the tissue sample is often sent for **biomarker testing** (also called molecular or tumor profiling). This testing looks inside tumor cells to identify the specific **genetic and molecular changes driving the tumor's growth**. You might see these findings listed on your biomarker report, and below is a high-level overview of what they could mean.

Many **biomarker alterations are identified through multigene panel testing**, including next-generation sequencing (NGS), which can scan hundreds of genes and analyze their DNA and RNA all at once. Depending on the type of tumor, additional specialized tests may also be used to identify other important biomarkers.

Together, these results help your care team **confirm or refine your diagnosis**, **guide treatment decisions**, and determine whether **targeted therapies or clinical trials** may be appropriate for you. Use this information as a starting point when talking with your health care team.

***Important Note**: This information is for educational purposes only and is not intended to replace professional medical advice, diagnosis, or treatment. Biomarker results are highly complex and must be interpreted alongside your individual diagnosis and overall clinical status.*

The scientific landscape continues to evolve rapidly. As new data emerges, biomarker classifications, testing methods, and treatment guidelines are subject to change. Always consult your doctor to understand what your specific biomarker results mean for your diagnosis, treatment decisions, and clinical trial opportunities.

ATRX

Associated Names: ATRX mutation, ATRX loss, loss of ATRX expression

What it is: ATRX is a gene that helps maintain the structure and stability of DNA within cells. When changes occur in the ATRX gene, cells can have difficulty maintaining normal DNA organization, which may contribute to tumor growth.

What this could mean if you see it on your report:

- This is a diagnostic marker that helps your care team determine the type of glioma you have. Loss of ATRX is commonly seen in astrocytomas, while oligodendrogliomas typically retain ATRX.
- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.

BRAF

Associated Names: BRAF alteration, BRAF fusion, BRAF V600E, KIAA1549-BRAF

What it is: The BRAF gene makes a protein that acts like a “power switch” to help control cell growth. Changes in the BRAF gene can turn this switch on, sending signals for the tumor to grow. These changes typically happen in two ways:

- ***BRAF Mutation (like V600E)***: This is a specific change in the genetic code. The BRAF V600E mutation is recognized in the 2021 WHO Classification of Tumors of the Central Nervous System as a defining or characteristic feature of certain gliomas, particularly some low-grade tumors.

- ***BRAF Fusion***: A fusion occurs when the BRAF gene joins with another gene, creating an abnormal protein that continuously signals cells to grow. The most common BRAF fusion in brain tumors is KIAA1549-BRAF.

What this could mean if you see it on your report:

- Clinical trial options may be available targeting a BRAF alteration.
- If biomarker testing identifies a BRAF fusion or a BRAF V600 mutation: An FDA-approved targeted therapy called tovorafenib (Ojemda) may be an option for patients 6 months and older whose low-grade glioma (LGG) has returned or has not responded to prior treatment.
  - Patient medication assistance program: Everyday Support
- If biomarker testing identifies a BRAF V600E mutation: An FDA-approved combination of targeted therapies, dabrafenib + trametinib (Taflinar + Mekinist), may be used in patients 1 year and older with low-grade glioma (LGG) when treatment is needed.
  - Patient medication assistance program: Novartis Patient Assistance

CDKN2A/B

Associated Names: CDKN2A/B deletion, CDKN2A/B homozygous deletion

What it is: CDKN2A and CDKN2B (Cyclin-Dependent Kinase Inhibitor 2A/B) are neighboring "tumor suppressor" genes that provide instructions for making proteins that control how cells grow and divide. These genes act like "brakes" for the cell, preventing it from dividing too quickly. When a homozygous deletion occurs, it means both copies of these genes are missing from the tumor cells. Without these brakes, the tumor cells can grow and divide uncontrollably.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.

EGFR

Associated Names: EGFR amplified or amplification, EGFR expression, EGFRvIII

What it is: EGFR (Epidermal Growth Factor Receptor) is a gene that provides instructions for making a protein on the surface of cells that helps control cell growth. Amplification is the most common change, which means the tumor has too many copies of the EGFR gene. A mutation, such as EGFRvIII, means that the growth signal is permanently on, fueling faster and more aggressive tumor cell growth.

What this could mean if you see it on your report:

- Clinical trial options may be available targeting an EGFR alteration.
- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.

FGFR

Associated Names: FGFR alteration, FGFR1, FGFR2, FGFR3, FGFR fusion, FGFR amplification

What it is: FGFR (Fibroblast Growth Factor Receptor) refers to a family of genes that help control how cells grow, divide, and repair themselves. When changes occur in an FGFR gene — such as a fusion (where FGFR joins with another gene) or an amplification (extra copies of the gene) — the signal that tells cells to grow can get stuck in the "on" position, causing tumor cells to grow uncontrollably.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.
- Clinical trial options may be available targeting the FGFR alteration.

H3K27M

Associated Names: H3K27M mutation, H3 K27-altered, loss of H3K27me3

What it is: H3K27M is a change in a gene that provides instructions for making a protein called histone H3. Histones help organize and protect our DNA. In H3K27M, one building block of the protein is swapped for another at a spot called "position 27." This single change disrupts how the cell normally switches genes on and off, broadly altering gene activity in ways that drive aggressive tumor growth.

What this could mean if you see it on your report:

- Clinical trial options may be available targeting the H3K27M alteration.
- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.
- If biomarker testing identifies an H3K27M alteration, an FDA-approved targeted therapy, dordaviprone (Modeyso), is available for adults and children 1 year of age and older with diffuse midline glioma that has progressed following prior treatment.
  - Patient medication assistance program: ChimerixCares

IDH

Associated Names: IDH1, IDH2, IDH mutant, IDH wildtype

What it is: IDH (Isocitrate Dehydrogenase) is a gene that helps cells process energy and function normally. When a change occurs in the IDH gene, called an IDH mutation, tumor cells produce substances that can affect how the tumor grows and behaves. IDH status is a key factor in classifying adult diffuse glioma subtypes as IDH-mutant or IDH-wildtype.

What this could mean if you see it on your report:

- Clinical trial options may be available targeting the IDH mutation.
- This is a diagnostic marker. Your care team uses your IDH status to help classify the specific subtype of your glioma.
- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. IDH-wildtype tumors are typically more aggressive and include glioblastoma (GBM).
- If biomarker testing identifies an IDH mutation, an FDA-approved targeted therapy, vorasidenib (Voranigo), is available for adults with grade 2 IDH-mutant astrocytoma or oligodendroglioma.
  - Patient medication assistance program: ServierOne

Ki-67

Associated Names: Ki-67, MIB-1, proliferation index, labeling index

What it is: Ki-67 is a protein found inside cells that are actively dividing. When a pathologist examines tumor tissue, they measure what percentage of cells are making this protein. This is called the proliferation index or labeling index, and it is reported as a percentage. A higher percentage means more cells are dividing at once, which is generally a sign that the tumor is growing more quickly. Unlike the other markers on this page, Ki-67 is not a mutation, it is a measurement of tumor activity.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. A higher Ki-67 index is generally associated with faster-growing tumors, though it is always interpreted alongside other biomarkers and imaging findings.
- This result alone does not determine your treatment; it is a measurement of tumor activity.
- In gliomas, the level of Ki-67 expression is roughly proportional to the tumor grade.

MGMT Promoter Methylation

Associated Names: MGMT unmethylated or negative, MGMT methylated or positive

What it is: MGMT (O6-methylguanine-DNA methyltransferase) is a gene that produces a protein responsible for repairing damaged DNA in cells. In some brain tumors, the MGMT gene is "turned off" through a process called promoter methylation. When the gene is methylated, the tumor cell has a harder time repairing itself, which can make it more sensitive to certain treatments, like chemotherapy.

What this could mean if you see it on your report:

- This is a predictor of a favorable therapeutic response to the FDA-approved therapy temozolomide (Temodar).
- Clinical trial options may be available targeting MGMT promoter methylation.
- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. Unmethylated (negative) status is often associated with a more treatment-resistant tumor.
- If your biomarker report includes a specific percentage or other quantitative measure of methylation (for example, "15%"), it reflects the amount of methylation detected by the specific test used. Your care team will interpret this value alongside the overall result (such as methylated/positive or unmethylated/negative) and the rest of your tumor's molecular profile.

MYCN

Associated Names: Ki-67, MIB-1, proliferation index, labeling index

What it is: MYCN (N-Myc Proto-Oncogene) is a gene that helps control how quickly cells grow and divide, especially during brain development before birth. Amplification means the tumor has created many extra copies of this gene, like turning the volume knob all the way up on a growth signal. This additional signaling drives tumor growth and more aggressive behavior.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.

NF1

Associated Names: NF1 mutation, Neurofibromatosis Type 1, NF1 loss

What it is: NF1 (Neurofibromin 1) is a gene that acts as a brake on cell growth by slowing down a signaling pathway called RAS/MAPK. When NF1 is changed or lost, that brake stops working, and cells can grow and divide too quickly. NF1 changes can occur as part of an inherited condition called Neurofibromatosis Type 1, but they can also appear in tumors in people without the inherited syndrome.

What this could mean if you see it on your report:

- Clinical trial options may be available targeting the NF1 alteration.
- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time.
- If you have an inherited NF1 condition, your care team may recommend genetic counseling for family members.
- NF1 mutations lead to the activation of the RAS/MAPK pathway, which opens the possibility of using FDA-approved targeted therapies to block this pathway.

NTRK

Associated Names: NTRK fusion, NTRK1, NTRK2, NTRK3

What it is: MYCN (N-Myc Proto-Oncogene) is a gene that helps control how quickly cells grow and divide, especially during brain development before birth. Amplification means the tumor has created many extra copies of this gene, like turning the volume knob all the way up on a growth signal. This additional signaling drives tumor growth and more aggressive behavior.

What this could mean if you see it on your report:

- Clinical trial options may be available targeting the NTRK alteration.
- If biomarker testing identifies an NTRK gene fusion, FDA-approved targeted therapies, larotrectinib (Vitrakvi) and entrectinib (Rozlytrek), may be options for adults and children with solid tumors that have spread or cannot be removed with surgery.
  - Patient medication assistance programs: Vitrakvi Patient Assistance and Genentech Patient Support Services

PDGFRA

Associated Names: PDGFRA amplification, PDGFRA mutation, PDGFRA alteration

What it is: PDGFRA (Platelet-Derived Growth Factor Receptor Alpha) is a gene that provides instructions for making a protein on the surface of cells that helps control cell growth and division. When the PDGFRA gene has too many copies (amplification) or a change (mutation), the growth signal is turned up too high, causing tumor cells to grow more aggressively. PDGFRA is the second-most frequently altered receptor gene in glioblastoma, after EGFR.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.
- Clinical trial options may be available targeting the PDGFRA alteration.

TERT

Associated Names: TERT promoter mutation

What it is: TERT (Telomerase Reverse Transcriptase) is a gene involved in maintaining the ends of chromosomes, which helps regulate how cells divide. When TERT is altered (called a promoter mutation), tumor cells can continue dividing rather than stopping.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.
- This is a diagnostic marker. TERT mutations often appear in IDH-wildtype glioblastoma combined with EGFR amplification and/or 7+/10- as part of defining a glioblastoma diagnosis.

TP53

Associated Names: TP53 mutation, p53

What it is: TP53 (Tumor Protein 53) is a gene that tells the body how to make a protein called p53, often nicknamed the "guardian of the genome." Its job is to monitor cells for DNA damage; it either repairs the damage or tells the cell to "self-destruct" if it cannot be fixed, preventing tumors from forming. When a TP53 mutation occurs, this protective protein stops working, allowing damaged cells to grow and divide uncontrollably.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.

ZFTA

Associated Names: ZFTA fusion, ZFTA-RELA fusion, C11orf95-RELA, ST-ZFTA

What it is: ZFTA (Zinc Finger Translocation Associated) is a gene found on chromosome 11. In some brain tumors, this gene breaks apart and fuses with another gene, most commonly a gene called RELA. This fusion creates an abnormal protein that keeps sending "grow" signals to cells when it should not. The ZFTA-RELA fusion produces a protein that activates a cell-signaling pathway called NF-κB, driving tumor cell growth.

What this could mean if you see it on your report:

- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time. An alteration is often associated with more aggressive tumor behavior.
- Clinical trial options may be available targeting a ZFTA alteration.
- You may see the older name "RELA fusion" on earlier pathology reports. The 2021 WHO classification renamed this category to reflect that ZFTA is the key gene involved.

1P/19Q

Associated Names: 1p/19q codeletion

What it is: 1p/19q refers to the loss of two specific chromosome segments in tumor cells or the complete deletion of both the short arm of chromosome 1 (1p) and the long arm of chromosome 19 (19q). When both are missing, it is called a 1p/19q codeletion.

What this could mean if you see it on your report:

- This is a diagnostic marker that helps your care team confirm an oligodendroglioma diagnosis at the molecular level, as a 1p/19q codeletion found in combination with an IDH mutation defines this specific tumor type.

+7/−10 (Chromosome 7 Gain / Chromosome 10 Loss)

Associated Names: +7/−10, chromosome 7 gain, chromosome 10 loss, 7+/10−

What it is: Human cells normally have two copies of every chromosome. In some brain tumors, the cells have gained an extra copy of chromosome 7 (which carries genes that speed up growth) while also losing a copy of chromosome 10 (which carries genes that slow tumor growth). Together, these two changes tip the balance strongly in favor of tumor growth.

What this could mean if you see it on your report:

- This is a diagnostic marker that helps your care team confirm a glioblastoma diagnosis at the molecular level, as the 2021 WHO classification recognizes the combined gain of chromosome 7 and loss of chromosome 10 as a feature that can define glioblastoma even if the cells do not look high-grade under a microscope.
- This is a prognostic marker, which is a sign that helps your care team understand how the tumor may behave over time.

References:

- National Cancer Institute. (n.d.). NCI Dictionary of Cancer Terms. U.S. Department of Health and Human Services, National Institutes of Health. https://www.cancer.gov/publications/dictionaries/cancer-terms/
- Agarwal, A., Edgar, M. A., Desai, A., Gupta, V., Soni, N., & Bathla, G. (2024). Molecular GBM versus Histopathological GBM: Radiology-pathology-genetic correlation and the new WHO 2021 definition of glioblastoma. American Journal of Neuroradiology, 45(8), 1006–1012. https://doi.org/10.3174/ajnr.A8225
- Louis, D. N., Perry, A., Wesseling, P., Brat, D. J., Cree, I. A., Figarella-Branger, D., Hawkins, C., Ng, H. K., Pfister, S. M., Reifenberger, G., Soffietti, R., von Deimling, A., & Ellison, D. W. (2021). The 2021 WHO classification of tumors of the central nervous system: A summary. Neuro-Oncology, 23(8), 1231–1251. https://doi.org/10.1093/neuonc/noab106
- Reifenberger, G., & von Deimling, A. (2022). Updates in the classification of ependymal neoplasms: The 2021 WHO Classification and beyond. Brain Pathology, 32(4), e13068. https://doi.org/10.1111/bpa.13068
- U.S. Food and Drug Administration. (2022). FDA approves entrectinib for NTRK solid tumors. FDA Center for Drug Evaluation and Research. https://www.fda.gov/drugs/resources-information-approved-drugs/fda-approves-entrectinib-ntrk-solid-tumors
- U.S. Food and Drug Administration. (2023). FDA approves dabrafenib with trametinib for pediatric patients with low-grade glioma with a BRAF V600E mutation. FDA Center for Drug Evaluation and Research. https://www.fda.gov/drugs/resources-information-approved-drugs/fda-approves-dabrafenib-trametinib-pediatric-patients-low-grade-glioma-braf-v600e-mutation
- U.S. Food and Drug Administration. (2024, April 23). FDA grants accelerated approval to tovorafenib for patients with relapsed or refractory BRAF-altered pediatric low-grade glioma. FDA Center for Drug Evaluation and Research. https://www.fda.gov/drugs/resources-information-approved-drugs/fda-grants-accelerated-approval-tovorafenib-patients-relapsed-or-refractory-braf-altered-pediatric
- U.S. Food and Drug Administration. (2023). FDA grants accelerated approval to dordaviprone for diffuse midline glioma. FDA Center for Drug Evaluation and Research. https://www.fda.gov/drugs/resources-information-approved-drugs/fda-grants-accelerated-approval-dordaviprone-diffuse-midline-glioma
- U.S. Food and Drug Administration. (2024). FDA approves vorasidenib for grade 2 astrocytoma or oligodendroglioma with a susceptible IDH1 or IDH2 mutation. FDA Center for Drug Evaluation and Research. https://www.fda.gov/drugs/resources-information-approved-drugs/fda-approves-vorasidenib-grade-2-astrocytoma-or-oligodendroglioma-susceptible-idh1-or-idh2-mutation

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