TYPES OF BIOMARKERS

The chart below lists specific biomarkers and their possible roles in brain tumor diagnosis, prognosis and prediction of response to therapy and treatment.

BIOMARKER	WHAT IS IT?	ADVANTAGES OF TESTING	WHAT TYPE OF TUMOR?
MGMT- MGMT or Methylation of the O6-methylguanine-DNA methyltransferase	MGMT is a protein that repairs errors in DNA. When the gene encoding MGMT is silenced by methylation, chemotherapy may be more effective because cancer cells cannot repair cellular damage.	Testing for the MGMT gene promoter has been used to identify whether or not a patient could benefit from the chemotherapy drug temozolomide. It is also useful in determining whether a patient is eligible to participate in certain clinical trials.	Anaplastic astrocytoma Anaplastic oligodendroglia Anaplastic oligoastrocytoma Glioblastoma Anaplastic gliomas
IDH1/IDH2	IDH1/IDH2 are key metabolic enzymes that help to produce energy for cells and have now been found to be mutated in additional cancers. The mutations in IDH1/IDH2 appear to alter the genetic regulation and programming of the tumor cells, causing them to continue to grow and divide and not develop into normal cells.	IDH1/2 mutation testing is performed as part of the diagnostic workup for many brain tumors. Identification of IDH1/2 mutations can help to confirm that a lesion is a tumor (and not some sort of inflammatory process), diagnose specific subtypes of tumors and provide useful information about the prognosis for that tumor type.	Occur mainly in low grade gliomas
1p/19q	The p-arm of chromosome 1 and the q-arm of chromosome 19 are found in all cells, but are frequently missing in oligodendrogliomas due to a deletion mutation	The 1p/19q test looks at genetic changes to chromosome numbers 1 and 19 in tumor cells and whether these chromosomes are complete or have a section missing. If sections of 1p/19q are found missing, research shows this could mean better outcomes for people with some types of brain tumors.	Oligodendroglimoa Anaplastic oligodendroglioma Oligoastrocytoma Anaplastic oligoastrocytoma
BRAF	BRAF is a gene that makes a protein called B-raf. The B-raf protein is important because it sends signals to help direct the growth of cells within our body. It is part of the MAP Kinase pathway, a longstanding cancer target. BRAF mutations are activating mutations, turning the gene on and enabling extra growth of cells.	Research has found that brain tumors (some types of grade 1 and 2 astrocytoma, including grade 1 pilocytic astrocytoma), especially pediatric gliomas, may have a fault with their BRAF gene. The "V600E" mutation in BRAF is a target of several drugs developed for treatment of melanoma. Individuals whose gliomas have a BRAF V600E mutation may benefit from these melanoma drugs (e.g. vemurafenib).	BRAF testing is only clinically useful in a few selected tumor types and is most commonly used to determine whether a tumor is a pilocytic astrocytoma. Typically, BRAF mutation are limited to pediatric gliomas.

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EGFR- Epidermal Growth Factor Receptor	EGFR is a member of the epidermal growth factor family and key cell signaling protein that is crucial for tumor growth. The EGFR signaling pathway is thought to play a crucial role in how a GBM tumor develops, continues to grow and spread, and it's resistance to therapy.	Most genes exist as two copies — one from mom and one from dad. In glioma cells, the EGFR gene is often amplified so that the cancer cells have many additional copies of this important growth factor. EGFR testing can determine the number of copies that exist in glioma cells.	GBM
EGFRvIII	EGFRvIII is a mutated form of EGFR. It has been found in about 30% of glioblastoma.	EGFRvIII mutation turns on EGFR growth-factor signaling when it would otherwise be turned off. Like EGFR amplification, EGFRvIII mutations are associated with more growth-factor signaling and a rise in the number of glioma cells.	GBM
PTEN	The PTEN gene codes for the PTEN protein, a known tumor-suppressor genes. It is mutated in a large number of different cancers. The normal PTEN protein inhibits cell growth.	The PTEN gene is frequently mutated in glioblastoma. When patients with grade II or grade III astrocytomas acquire PTEN mutations, it may be an indicator that the tumor is progressing to become a grade IV glioma (secondary glioblastoma).	GBM Astrocytoma
TERT	The TERT gene encodes telomerase, and enzyme that produces protective caps at the ends of chromosomes. These caps are called telomeres, and they shorten as cells age, eventually causing cell death.	The mutations turn on the TERT gene, enabling cancer cells to keep their telomeres long. By maintaining long telomeres, glioma cells can divide indefinitely without aging and dying. These mutations are associated with better prognosis in patients with IDH-mutated gliomas, but with worse prognosis in patients with gliomas lacking an IDH mutation.	TERT mutations are found in 80% of glioblastomas and oligodendrogliomas, and 25% of grade II/III astrocytomas.
ATRX	The ATRX gene alters DNA conformation in order to regulate which genes are expressed and which are silenced. It is also important for maintaining DNA integrity.	Mutations in ATRX are observed in up to 80% of grade II/III astrocytomas, where they commonly co-occur with IDH mutation and are assoicateed with extremely long telomeres. ATRX mutations may have prognostic importance, but whether this is independent of the effects of IDH mutation remains unclear.	Grade II/III astrocytoma Secondary glioblastoma
Akt3	Protein that is highly active in glioblastoma and which interacts with the additional glioma-relevant genes PIK3CA and PIK3R1.	Akt3 presence may indicate a resistance to standard treatment.	GBM