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Pictured: A microscopic view of a typical neuroblastoma with rosette formation. Ching-An Peng and his research team have shown that neuroblastoma cells undergo premature death when they ingest antibody-tagged carbon nanotubes and are irradiated with 808-nm near infrared laser light.

Cancer nanotechnology

Targeting and eradicating tumor cells with nanomaterials

Many cancer treatments have their own sets of risks and consequences. Among those is chemotherapy, which introduces poisons or toxins into the body to damage, shrink, or kill cancerous cells. Unfortunately, chemotherapy also can destroy healthy cells, leaving the patient with serious, unpleasant side effects.

Phototherapy and molecular targeting are two separate methods that have shown great potential as localized—and therefore less invasive—cancer treatment. Ching-An Peng has been working to fine-tune them both.

"Among the many nanomaterials designed and synthesized for biomedical applications, the carbon nanotube, because of its unique ability to absorb near infrared light, is a promising option for localized phototherapy," Peng explains.

When armed with a specific monoclonal antibody, a carbon nanotube can be ingested by corresponding cancer cells. This internalization occurs via a biochemical process whereby cells engulf the nanotube with their cell membrane.

Peng and his team have conducted phototherapy experiments using two different antibodies. One antibody is able to specifically target neuroblastoma cells. Neuroblastoma, a cancer of the sympathetic nervous system, is the most common cancer in infants. The other antibody is able to recognize glioblastoma stem-like cells. Glioblastoma is the most common and most aggressive primary brain tumor in adults. "Cancer cells ingested with antibody-tagged carbon nanotubes and irradiated with 808-nm near infrared laser light which can pass through the skin were all found to die under this light while other cells were unaffected," says Peng.

Colorectal cancer is another focus for the team, which is investigating the use of prodrugs as an effective treatment. "Prodrugs are pharmacologically inactive molecules that require an enzymatic and/or chemical transformation to release a cell-killing drug," Peng explains. The use of a prodrug strategy increases the selectivity of a particular drug for its intended target. Gene-directed enzyme prodrug therapy has expanded the range of tumors that are susceptible to prodrug therapy. "But until now, delivery of the prodrug and the gene have been conducted via separate routes. Our goal is to come up with a nanocarrier that contains both the prodrug and its activating gene."

Peng's team has developed a polymeric nanocarrier that can move drugs into the cells that they are to treat. The action of a specific enzyme, turned on by the gene, converts the prodrug into a cell-killing agent that is delivered within the targeted malignant cells. The team has demonstrated the feasibility of using this nanocarrier to eradicate those few especially malignant cancer cell lines, such as those found in colorectal cancer—a major lethal disease in the American population.