Low Level Lasers

By Dan Murphy, D.C.

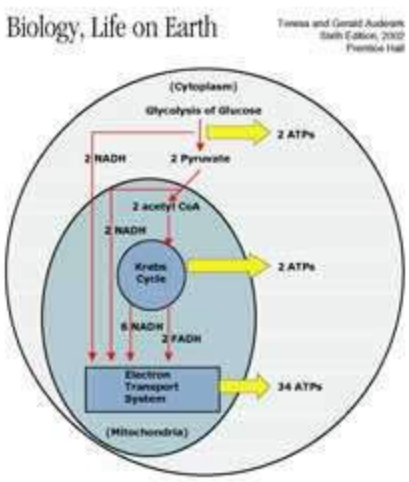
A hot topic within the profession is the use of cold lasers. Today's Chiropractic asked an authority on the subject, Dr. Dan Murphy, to tell us how this technology works. His response is featured below:

In 1997, Douglas Wallace1 wrote an article for Scientific American titled "Mitochondrial DNA In Aging and Disease." In this article, he notes that an intracellular organelle, the mitochondria, is the power plant of cells because it produces ATP energy.

"Mitochondria provide about 90 percent of the energy that cells, and thus tissues, organs and the body as a whole, need to function." Every cell in the body contains hundreds of mitochondria that produce the energy that the body requires.

Each mitochondria contains many copies of DNA, called mitochondrial DNA, or mtDNA. Mitochondrial DNA is separate and distinct from the cell's copy of nuclear DNA. Our mtDNA comes from our mother and is identical to our mother's mtDNA. Mitochondrial DNA (mtDNA) codes for 13 proteins (enzymes) required for the production of ATP energy.

A simplified image (after Audesirk) of the mitochondrial production of ATP energy follows:



Note that the primary producer of ATP energy is the "electron transport system" of the mitochondria. This is important in the understanding of laser physiology.

Wallace further notes, "Anything able to compromise ATP production in mitochondria could harm or even kill cells and so cause tissues to malfunction and symptoms to develop."
The inner membrane of the mitochondria contains four protein complexes called the respiratory chain. Electrons from food pass through these protein complexes with the help of Coenzyme Q10, interacting with oxygen and hydrogen to produce water and ATP energy.

"As the respiratory chain participates in energy production, toxic by-products known as oxygen free radicals are given off. These oxygen derivatives, which carry an unpaired electron, are highly reactive and can attack all components of cells, including respiratory chain proteins and mitochondrial DNA. Anything that impedes the flow of electrons through the respiratory chain can increase their transfer to oxygen molecules and promote the generation of free radicals."

Importantly, anything that improves the flow of electrons through the respiratory chain will increase the production of ATP while reducing the generation of free radicals. As we will learn, this is the key to low-level laser therapy.

Wallace notes: "The mitochondrial theory of aging holds that as we live and produce ATP, our mitochondria generate oxygen free radicals that inexorably attack our mitochondria and mutate our mitochondrial DNA." The accumulation of mitochondrial DNA mutations reduces ATP energy output below needed levels. "In doing so, the mutations and mitochondrial inhibition could contribute to common signs of normal aging, such as loss of memory, hearing, vision and stamina."

Hot Lasers vs. Cold Lasers

High powered lasers, such as hot lasers, use heat and destroy tissue. Low energy lasers or cold lasers affect the cellular energy of the underlying tissue. Hot lasers have a thermal effect and have an output of 1MW or higher. Cold lasers stimulate biological function and have an output below 10 milliwatts (ten- one thousands of a watt).

In support of the writings of Wallace is the 2004 book edited by Rainer Straub and Eugenio Mocchegiani2. These authors note: "One of the most accepted theories of ageing is the free radical theory of aging. "The overproduction of free radicals can induce cell death. Aging, as stated in free radical theory of aging is characterized by an increased production of free radicals in several tissues or a decreased antioxidant defense leading to chronic oxidative stress." The mitochondria are the major source for the production of free radicals.

Tiina Karu wrote "Low-Power Laser Therapy" in the Biomedical Photonics Handbook, in 20033. He notes that low-level laser therapy works because the laser light is absorbed by the mitochondria photoreceptors, which enhances cellular metabolism. This means the mitochondria produce more ATP as a result of exposure to laser light. He notes that the primary reaction of laser light is in the mitochondria, which results in increased APT energy. "The mechanism of low-power laser therapy at the cellular level is based on the increase of oxidative metabolism of mitochondria, which is caused by electronic excitation of components of the respiratory chain."

Karu states: "It is known that even small changes in ATP levels can significantly alter cellular metabolism." The elevated levels of ATP energy increase the rate of DNA synthesis.

Consequently, the increased levels of ATP energy and DNA synthesis will benefit acute and chronic musculoskeletal aches and pains, inflamed oral tissues, help to heal skin and mucosal ulcerations; treat edema, burns and dermatitis; relieve pain and treat chronic inflammation, as well as autoimmune diseases. Laser therapy is also used in sports medicine and rehabilitation clinics (to reduce swelling and hematoma, relieve pain, improve mobility and to treat acute soft-tissue injuries). It was shown in the 1980s that laser radiation altered the firing pattern of nerves, which is connected with pain therapy.

Possibly, the most authoritative text on low-level laser therapy is the 2002 book by Jan Turner and Lars Hode, titled "Laser Therapy Clinical Practice and Scientific Background4." This book contains 1,281 references. These authors note:

1. "Today, we can safely say that therapeutic lasers have an important biological effect and a very positive one at that."
2. "We believe that lasers have a tremendous and, as of yet, untapped potential in the field of healthcare."
3. "Therapeutic lasers have no undesirable side effects in the hands of a reasonably qualified therapist."
4. Lasers are "sterile, painless, and often less expensive than methods already in use," and do not have side effects as does pharmacotherapy.
5. "Laser therapy of wounds is ideal, since it promotes healing and reduces pain at the same time."
6. "Laser light increases the cell's ATP energy."

A recent representative article regarding low-level laser therapy was published October 2004 in the American Journal of Physical Medicine & Rehabilitation5. Researchers injured the knees of 42 rats giving them arthritis. Twenty-one of the rats were given 632 nm low-level laser, applied over the arthritic knee for 15 minutes, three times per week, for 8 weeks; the other 21 rats were not similarly exposed. The results showed a marked repair of arthritic cartilage in the lased rats, but not in the non-lased group. The authors concluded that the 632 nm low-power laser enhances protein production in arthritic joints and repairs the arthritic cartilage.

These authors also note: Laser is “thought to cause electronic excitation of the photoacceptor molecules, which are thought to be various cytochrome enzymes that are terminal electron carriers in the respiratory chain.” This is thought to accelerate electron transfer. “Electron transport in the mitochondrial membrane is one of the main fueling mechanisms underpinning metabolism and proliferation of cells, including generation of adenosine triphosphate (ATP).” Low-level laser mediated increase in efficiency of the electron carriers in the respiratory chain would increase generation of adenosine triphosphate, which could manifest itself as increased DNA and protein synthesis and result in cell proliferation, as shown in the present study.” Thus, their explanation of the physiology of low-level laser therapy is consistent with Karu3 and Turner4 above.

Turner4 notes: “any wavelength will have a biological effect.” Karu3 notes, “The 632.8 nm and the 820 nm are the most common wavelengths used in therapeutic light sources.” Turner4 and Baxter6 both note, “Shorter wavelengths have higher energy.” Baxter6 even gives the mathematical formula used to calculate energy based upon wavelength differences. Based upon the formula Baxter6 uses, a 632.8 nm laser has more energy than an 820 nm laser.

Turner states: “The first company to receive a 510(k) from the Federal Drug Administration (FDA) was Majes-Tes Innovations in the USA and its Erchonia laser.” Review of the FDA’s website notes that the evidence Erchonia used to achieve the FDA 510(k) status shows that its laser was 60 percent greater at improving pain and range of motion as compared to the placebo group. Turner also states: “All laser treatment should be preceded by a system-stimulating irradiation of the vertebrae that innervates the damaged area.” This is consistent with the chiropractic concept of spinal neurology influencing the health and physiology of peripheral tissues. Consequently, the Erchonia laser is a 635nm wavelength line-laser (as opposed to dot laser) with dual heads, one for the spine and one for the peripheral tissue. The spinal head is pre-set to the neurological tissue, while the other head is programmable to the specific peripheral pathology. Each head has four separate laser beams. Erchonia’s low-level lasers range in price between $4,500 and $12,900.

In summary, mitochondria present a paradox. They are the major producer of ATP energy, but they are also the major producer of free radicals. As the mitochondria produce the ATP energy that our bodies require to function, the mitochondria also produce the free radicals that damage and age our bodies. Lasers increase the mitochondrial production of ATP without increasing the production of free radicals. Anything that increases the production of ATP energy will speed healing and improve symptoms. Since lasers can achieve this without side effects or risks, low-level laser therapy is here to stay.

References

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