## Understanding concussion on the cellular level

In 2014, UCLA neurologist Dr. Christopher Giza co-authored a paper detailing what occurs to neurons in the brain after a concussion. Giza pieced together his findings from animal studies and results of more severe brain trauma in humans.

POTASSIUM

CALCIUM

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## NEUROTRANSMITTERS RELEASED POSTSYNAPTIC NEURON **PRESYNAPTIC NEURON HEALTHY CELL** NUCLEUS ION PUMP 1 Neuron communicates with other brain cells via neurotransmitters DENDRITE that travel through the axon. 2 Axon is protected by a myelin sheath. MYÈLIN 3 Each cell is a link in a chain that carries TERMINAL messages from the brain to the body. AXON **IMPACT** MITOCHONDRIA Concussion caused when rotational **RETURN TO HEALTH** and/or linear acceleration is applied to the brain. The acceleration causes If adequate recovery neurons to stretch. time is allowed, the cell is believed to return to normal, **INJURY** healthy function. 1 Cell membrane stretches, allowing calcium in and letting potassium out. 2 Neurotransmission spikes, causing calcium and potassium fluxuation in neighboring cells. SYMPTOMS: Potential loss of consciousness, intense headache and sensitivity to light and sound. **RECOVERY PHASE (OFTEN 7-10 DAYS)** 1 Calcium hinders mitochondria function, resulting in depressed cell energy. **2** Cell burns through energy trying to pump calcium out and regain balance; low energy impedes cell function. 3 Calcium damages axon structure, which impedes neurotransmission. SYMPTOMS: Memory and stability problems, slower processing and heightened vulnerability to more damage. **FURTHER DAMAGE** 1 If the neuron is stretched again before it heals, problems likely are exacerbated. 2 Axon damage worsens and neurotransmission is further hindered. 3 Cell function and energy levels are greatly **SYMPTOMS:** Cognitive and stability problems worsen and recovery lengthens.