In article “Brain-inspired learning in artificial neural networks: A review”, authors offer a review that seeks to identify the mechanisms of learning in the brain that have inspired current artificial intelligence algorithms. The scope of this review is for algorithms that modify the parameters of a neural network, such as synaptic plasticity, and how they relate to the brain. To better understand the biological processes underlying natural intelligence, the first section explores the low-level components that shape neuromodulation, from synaptic plasticity to the role of local and global dynamics that shape neural activity. This is related back to ANNs in the third section, where ANNs with biological neural systems are compared. Finally, authors discuss various applications of these AI techniques in real-world scenarios, highlighting their potential impact on fields such as robotics, lifelong learning, and neuromorphic computing.

Authors propose several mechanisms to explain the biological basis of learning at varying levels of granularity.

1. Synaptic plasticity: Plasticity in the brain refers to the capacity of experience to modify the function of neural circuits.
2. Neuromodulation: The brain adapts to new information is through neuromodulation.
3. Metaplasticity: The ability of neurons to modify both their function and structure based on activity is what characterizes synaptic plasticity.
4. Neurogenesis: The process by which newly formed neurons are integrated into existing neural circuits.
5. Glial cells: Glial cells, or neuroglia, play a vital role in supporting learning and memory by modulating neurotransmitter signaling at synapses.

Researchers have been exploring spiking neural networks (SNNs) as an alternative to ANNs. SNNs are a class of ANNs that are designed to more closely resemble the behavior of biological neurons. The primary difference between ANNs and SNNs is the idea that SNNs incorporate the notion of timing into their communication. Spikes have been theoretically demonstrated to contain more information than rate-based representations of information (such as in ANNS), despite being both binary and sparse in time. Despite these potential advantages, SNNs are still in the early stages of development, and there are several challenges that need to be addressed before they can be used more widely. One of the most pressing challenges is regarding how to optimize the synaptic weights of these models, as traditional backpropagation based methods from ANNs fail due to the discrete and sparse nonlinearity.