EJPMR, 2026, 13(4), 231-235 **Research Article** **Impact Factor: 8.158**

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

ISSN (O): 2394-3211
ISSN (P): 3051-2573
Coden USA: EJPMAG

PHYSIOLOGICAL BASIS OF NERVE FIBRE STIMULATION, SUMMATION AND THE CONCEPT OF MINIMUM DOSE: A NEUROPHYSIOLOGICAL PERSPECTIVE

***Dr. A. K. Dwivedi**

Director & Chief Executive Officer (CEO), Advanced Homoeo Health Center & Homoeopathic Medical Research Pvt. Ltd. Indore, Madhya Pradesh, India.
Member, Executive Council, Devi Ahilya Vishwavidyalaya, Indore.
Professor & Head, Department of Physiology, SKRP Gujarati Homoeopathic Medical College, Indore.
Member, Scientific Advisory Board, Central Council for Research in Homoeopathy (CCRH), Ministry of Ayush, Government of India.
Member, Scientific Advisory Committee, North Eastern Institute of Ayurveda & Homoeopathy (NEIAH), Shillong, Meghalaya, Ministry of Ayush, Government of India.

***Corresponding Author: Dr. A. K. Dwivedi**

Director & Chief Executive Officer (CEO), Advanced Homoeo Health Center & Homoeopathic Medical Research Pvt. Ltd. Indore, Madhya Pradesh, India.
DOI: https://doi.org/10.5281/zenodo.19326815

How to cite this Article: *Dr. A. K. Dwivedi. (2026). Physiological Basis Of Nerve Fibre Stimulation, Summation And The Concept Of Minimum Dose: A Neurophysiological Perspective. European Journal of Pharmaceutical and Medical Research, 13(4), 231–235.

Article Received on 03/03/2026 **Article Revised on 23/03/2026** **Article Published on 01/04/2026**

ABSTRACT

The excitability of nerve fibres and the mechanisms by which stimuli evoke physiological responses are fundamental aspects of neurophysiology. Nerve fibres respond to stimuli only when the stimulus intensity reaches a critical threshold level capable of generating an action potential. However, stimuli below this threshold—referred to as subminimal or subthreshold stimuli—do not produce a response independently but may contribute to excitation through the process of summation. Summation occurs when multiple weak stimuli combine either spatially or temporally to produce a depolarization sufficient to reach the firing threshold. The physiological understanding of minimum stimulus, subminimal stimulus, and summation is essential for explaining reflex activity, neural integration, and coordinated bodily responses. This article elaborates on the mechanisms of nerve fibre stimulation, the electrophysiological basis of action potential generation, and the physiological processes of summation. It further discusses the conceptual relevance of these mechanisms to therapeutic principles such as minimum dose used in homoeopathic medicine. The discussion integrates classical neurophysiological concepts established by Sherrington with modern explanations found in the works of Guyton and Ganong.

KEYWORDS: NERVE FIBRE STIMULATION, ACTION POTENTIAL, MINIMUM STIMULUS, SUBTHRESHOLD STIMULUS, SUMMATION, NEUROPHYSIOLOGY, REFLEX PHYSIOLOGY etc……

INTRODUCTION

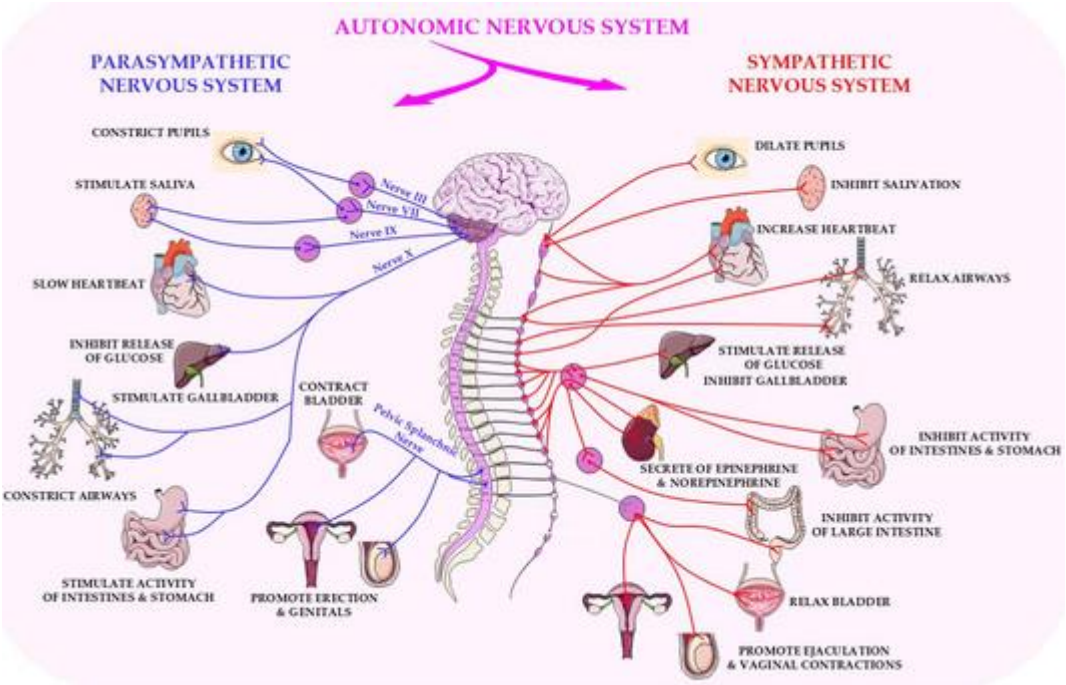
The nervous system is responsible for detecting environmental changes, processing sensory information, and coordinating responses that maintain homeostasis. At the fundamental level, these processes depend on the excitability of nerve fibres, which enables them to generate and propagate electrical impulses known as action potentials.

The ability of nerve fibres to respond to stimuli is governed by certain physiological principles. Among these principles, the concepts of threshold stimulus, subminimal stimulus, and summation play crucial roles in determining whether a nerve impulse will be generated.

In experimental physiology, nerve stimulation is often studied using electrical stimuli because electrical stimulation allows precise control of stimulus intensity, duration, and frequency. Early physiologists demonstrated that nerve fibres obey the all-or-none law, meaning that once the threshold is reached, the response is maximal and independent of stimulus strength.

However, the nervous system rarely operates through single large stimuli. Instead, multiple small stimuli arriving from different receptors may combine to produce a response. This process is called summation, a phenomenon extensively described by the British neurophysiologist Sir Charles Scott Sherrington, who demonstrated how reflex responses result from the integration of numerous excitatory inputs.

The understanding of these physiological processes provides insight into how weak stimuli can collectively produce effective biological responses. This article aims to present an elaborated discussion on nerve fibre stimulation, the physiological basis of minimum stimulus, the nature of subminimal stimuli, and the mechanisms of summation.



Representative Images.

Structure and Physiological Properties of Nerve Fibres

Nerve fibres are specialized cellular extensions of neurons designed for the rapid conduction of electrical impulses. Structurally, a nerve fibre consists of:

- Axon
- Axonal membrane
- Myelin sheath (in myelinated fibres)
- Nodes of Ranvier

The axonal membrane is electrically excitable due to the presence of ion channels that regulate the movement of sodium, potassium, calcium, and chloride ions across the membrane.

Several physiological properties characterize nerve fibres

1. Excitability
2. Conductivity
3. All-or-None Law
4. Refractory Period
5. Accommodation
6. Adaptation
7. Indefatigability

Among these properties, excitability is the most fundamental, as it determines the ability of the nerve fibre to respond to stimulation.

Mechanisms of Nerve Fibre Stimulation

A nerve fibre can be stimulated by different forms of energy capable of altering the electrical state of the membrane. These stimuli include:

Mechanical Stimuli

Mechanical forces such as pressure, stretch, or deformation can activate mechanosensitive ion channels, resulting in depolarization of the nerve membrane.

Thermal Stimuli

Temperature changes, especially extreme heat or cold, can stimulate sensory receptors and initiate nerve impulses.

Chemical Stimuli

Chemical substances such as neurotransmitters, ions, or pharmacological agents can modify membrane permeability and stimulate nerve fibres.

Electrical Stimuli

Electrical stimulation is widely used in experimental physiology because it allows accurate control of stimulus parameters such as:

- Intensity
- Duration
- Frequency

When an adequate electrical stimulus is applied to a nerve fibre, it produces a rapid change in membrane potential known as an action potential.

Action Potential and Nerve Impulse Generation
The generation of an action potential involves a series of changes in membrane permeability.

At rest, the nerve membrane maintains a resting membrane potential of approximately −70 millivolts. This potential exists because the membrane is selectively permeable to ions.

When a stimulus reaches the threshold level, the following events occur

1. Depolarization
Sodium channels open rapidly, allowing sodium ions to enter the cell. This causes the membrane potential to become positive.

2. Overshoot
The membrane potential briefly becomes positive relative to the outside.

3. Repolarization
Potassium channels open, allowing potassium ions to exit the cell, restoring the negative potential.

4. Hyperpolarization
The membrane potential temporarily becomes more negative than the resting level.

5. Return to Resting State
These events collectively constitute the action potential, which travels along the nerve fibre as a propagated electrical impulse.

Minimum Stimulus (Threshold Stimulus)
The minimum stimulus, also called the threshold stimulus, is defined as
The smallest intensity of stimulus capable of producing an action potential in a nerve fibre.

If the stimulus strength is below this level, the nerve fibre will not generate an action potential. Once the threshold is reached, the nerve fibre responds according to the all-or-none law, meaning that the amplitude of the action potential remains constant regardless of further increases in stimulus intensity.

This principle ensures reliability in nerve impulse transmission and prevents distortion of signals.

Subminimal (Subthreshold) Stimulus
A subminimal stimulus refers to a stimulus whose intensity is insufficient to produce an action potential.

Such stimuli produce only a small localized change in membrane potential known as a local potential. This local depolarization may decay quickly and fail to propagate along the nerve fibre.

However, subminimal stimuli are not physiologically insignificant. Under certain conditions, they may contribute to excitation through the mechanism of summation.

Summation in Neurophysiology
Summation is a fundamental property of the nervous system that allows the integration of multiple weak stimuli.

Summation can be defined as:
The process by which several subthreshold stimuli combine to produce a depolarization sufficient to reach the threshold level and generate an action potential.

This phenomenon is particularly important in reflex activity and synaptic transmission.

Sherrington described the nervous system as an integrative mechanism in which multiple excitatory and inhibitory influences determine the final response of a neuron.

Types of Summation
Two principal forms of summation are recognized in physiology.

Temporal Summation
Temporal summation occurs when multiple stimuli are applied in rapid succession to the same nerve fibre.

Each stimulus produces a small depolarization that has not yet disappeared when the next stimulus arrives. The effects of these stimuli accumulate, gradually increasing the membrane potential until it reaches the threshold.

Once the threshold is reached, an action potential is generated.

Temporal summation is important in sensory perception and motor control, where repetitive stimulation enhances neuronal activity.

Spatial Summation
Spatial summation occurs when multiple subminimal stimuli are applied simultaneously at different locations.

In this case, several nerve fibres or receptors transmit signals that converge on a single neuron. The combined excitatory postsynaptic potentials may reach the threshold level and produce an action potential.

Spatial summation allows the nervous system to integrate information from multiple sensory sources.

Summation in Reflex Physiology
Reflex actions represent one of the most important physiological applications of summation.

A reflex arc typically involves
- Receptor
- Afferent nerve fibre
- Interneuron
- Motor neuron
- Effector organ

In many cases, a single weak stimulus may not produce a reflex response. However, repeated or simultaneous stimuli may activate multiple afferent fibres, leading to summation within the central nervous system.

This summated excitation ultimately activates motor neurons and produces a reflex response.

Physiological Significance of Summation
Summation serves several important physiological functions
1. Integration of sensory signals.
2. Regulation of motor activity.
3. Enhancement of weak stimuli.
4. Coordination of reflex actions.
5. Facilitation of neural communication.

Without summation, the nervous system would fail to respond to many subtle stimuli present in the environment.

Relationship Between Subminimal Stimulus and Desired Physiological Response
A single subminimal stimulus does not produce an action potential. However, when multiple subminimal stimuli occur together, their effects may accumulate.

This cumulative effect may eventually reach the threshold level required for nerve excitation.

Thus, a sequence of physiological events may occur:
Subminimal stimuli → Summation → Threshold reached → Action potential → Physiological response
This mechanism illustrates how the nervous system can transform multiple weak signals into a coordinated biological response.

Conceptual Relevance to the Principle of Minimum Dose
The principle of minimum dose is central to homoeopathic therapeutics. According to this principle, very small doses of a remedy are used to stimulate the body's self-regulatory mechanisms.

Although the mechanisms of homoeopathic medicines are still under investigation, the physiological concept of summation provides an interesting analogy.

In neurophysiology, multiple weak stimuli may combine to produce a significant response. Similarly, minimal therapeutic stimuli may interact with biological regulatory systems to produce measurable effects.

Further scientific research is required to explore the possible physiological correlations between these concepts.

CONCLUSION
The stimulation of nerve fibres represents a fundamental mechanism underlying neural communication and physiological regulation. A nerve fibre generates an action potential only when the applied stimulus reaches the threshold level.

Subminimal stimuli do not produce responses independently but may contribute to excitation through the process of summation. Temporal and spatial summation allow the nervous system to integrate multiple weak signals and convert them into effective responses.

Understanding these physiological mechanisms is essential for interpreting neural integration, reflex activity, and biological responsiveness to minimal stimuli.

These principles highlight the remarkable capacity of the nervous system to process subtle inputs and generate coordinated physiological outputs.

BIOGRAPHY
Dr. A. K. Dwivedi, BHMS (Gold Medallist), MD, MBA, Ph.D. has been a Registered Homeopaths for over 25 years. He is a Professor & HOD: Department of Physiology S.K.R.P. Gujarati Homoeopathic Medical College, Indore. He is a Member of Executive Council, Devi Ahilya VishwavidyalayaIndore, MP, INDIA, he is also a Member Scientific Advisory Board (CCRH) Ministry of Ayush, Govt of India. Member, Scientific Advisory Committee (NEAH) Shilong Meghalaya, Ministry of Ayush, Govt. of India,Member Academic Board Madhya Pradesh Medical Science University, Jabalpur MP (India). DIRECTOR,& CEO Advanced Homeo Health Centre & Homeopathic Medical Research Pvt.Ltd. Indore, Madhya Pradesh, India, EDITOR,"SEHAT EVAM SURAT"(Hindi Monthly Medical Magazine).

BIBLIOGRAPHY / REFERENCES
1. Wiesendanger M, Miles TS. Ascending pathway of low-threshold muscle afferents to the cerebral cortex and its possible role in motor control. Physiol Rev., 1982; 62(4): 1234–1270.
2. Colosimo, C.; Berardelli, A. Clinical phenomenology of dystonia. *Int. Rev. Neurobiol.*
3. Cardoso, F.; Jankovic, J. Dystonia and dyskinesia. *Psychiatr. Clin. N. Am.*, 1997; *20:* 821–838.

4. Hanz S, Fainzilber M. Retrograde signaling in injured nerve--the axon reaction revisited. J Neurochem, 2006 Oct; 99(1): 13-9.
5. ckerley R, Samain-Aupic L, Ribot-Ciscar E. Passive proprioceptive training alters the sensitivity of muscle spindles to imposed movements. *eNeuro* 9: ENEURO., 2022; 0249-0221.2021.
6. Hamilton LD, Mani D, Almuklass AM, Davis LA, Vieira T, Botter A, Enoka RM. Electrical nerve stimulation modulates motor unit activity in contralateral biceps brachii during steady isometric contractions. *J Neurophysiol.,* 2018; 120: 2603–2613.
7. Seizova-Cajic T, Smith JL, Taylor JL, Gandevia SC. Proprioceptive movement illusions due to prolonged stimulation: reversals and aftereffects. *PLoS One,* 2007; 2: e1037.
8. Guyton, Arthur C., and John E. Hall, Textbook of Medical Physiology, Elsevier Saunders, Philadelphia.
9. Ganong, William F., Review of Medical Physiology, McGraw-Hill Medical Publications.
10. Sherrington, Charles Scott., The Integrative Action of the Nervous Syste. Yale University Press.
11. Chatterjee, C. C., Human Physiology, Volume II., Medical Allied Agency, Kolkata.
12. Best, C. H., and Taylor, N. B., The Physiological Basis of Medical Practice, Williams& Wilkins.