OPEN ACCESS Freely available online

Applied Microbiology: Open Access

ISSN: 2471-9315

Opinion Article

Phagocytosis: A Fundamental Process in Immune Defense and Homeostasis

Mesele Admassie*

Department of Biology, Mekelle University, Mekelle, Ethiopia

DESCRIPTION

Phagocytosis is a critical biological process used by cells to engulf and digest foreign particles, microbes, dead cells, and debris. This process is central to the immune system and plays a significant role in maintaining tissue homeostasis. Phagocytosis is a type of endocytosis and is performed by specialized cells, primarily phagocytes, such as macrophages, neutrophils, and dendritic cells. These cells are part of the body's first line of defense, known as the innate immune system. Phagocytosis is a multi-step process involving recognition, engulfment, and digestion of particles. It begins when a phagocytic cell identifies a target through specific surface receptors. These receptors recognize patterns on the surface of the target, such as Pathogen-Associated Molecular Patterns (PAMPs) on microbes or Damage-Associated Molecular Patterns (DAMPs) on apoptotic cells. Pattern Recognition Receptors (PRRs) these recognize conserved microbial patterns. Examples include Toll-Like Receptors (TLRs) and C-type lectin receptors. These bind to the Fc region of antibodies that have opsonized (marked) pathogens. These recognize complement proteins bound to the surface of microbes. Upon recognition, the phagocyte forms pseudopodia (extensions of its plasma membrane) to surround the target, enclosing it within a membrane-bound vesicle known as a phagosome. Once internalized, the phagosome undergoes a maturation process, fusing with lysosomes to form a phagolysosome. Lysosomes contain hydrolytic enzymes such as proteases, lipases, and nucleases, which degrade the engulfed material. Additionally, Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS) may be produced within the phagolysosome to kill microbes. Phagocytosis is a primary mechanism for clearing microbial infections. Neutrophils and macrophages are particularly effective in ingesting and killing bacteria, fungi, and viruses. Phagocytes clear apoptotic cells and cellular debris, aiding in tissue regeneration and repair. Phagocytosis plays a pivotal role in antigen presentation. Dendritic cells and macrophages process engulfed antigens and present them on their surface *via* Major Histocompatibility Complex (MHC) molecules to T cells, bridging innate and adaptive immunity. Actin polymerization drives the extension of pseudopodia and the engulfment process. Signals from receptors, such as Phospho Inositide 3-Kinases (PI3Ks) and small GTPases like Rac and Cdc42, modulate the phagocytic process. The coating of particles with antibodies or complement proteins enhances recognition and uptake by phagocytes. Chronic Granulomatous Disease (CGD) a genetic disorder where phagocytes fail to produce ROS, impairing microbial killing. Dysregulation in the clearance of apoptotic cells may contribute to conditions like Systemic Lupus Erythematosus (SLE). Pathogens like *Mycobacterium tuberculosis* and *Listeria monocytogenes* have evolved mechanisms to evade or survive within phagocytes, leading to persistent infections. Therapies aimed at boosting phagocyte function could improve outcomes in infections and chronic inflammatory diseases. Drugs that counteract microbial strategies to evade phagocytosis are under investigation. Strategies to stimulate macrophages to engulf tumor cells are being developed.

CONCLUSION

Phagocytosis is a vital cellular process that safeguards the body against infections, maintains tissue integrity, and orchestrates immune responses. Despite its fundamental role, the complexities of its regulation and interactions with pathogens highlight the need for continued research. Advances in understanding phagocytosis hold promise for new treatments for infectious diseases, autoimmune conditions, and cancer, underscoring its importance in health and disease.

Correspondence to: Mesele Admassie, Department of Biology, Mekelle University, Mekelle, Ethiopia, E-mail: mesele206@gmail.com

Received: 27-Nov-2024, Manuscript No. AMOA-24-35779; **Editor assigned**: 29-Nov-2024, PreQC No. AMOA-24-35779 (PQ); **Reviewed**: 13-Dec-2024, QC No. AMOA-24-35779; **Revised:** 20-Dec-2024, Manuscript No. AMOA-24-35779 (R); **Published**: 27-Dec-2024, DOI: 10.35248/2471-9315.24.10.345

Citation: Admassie M (2024). Phagocytosis: A Fundamental Process in Immune Defense and Homeostasis. Appli Microbiol Open Access. 10:345.