The Complex Biology of Macrophages: Origins, Functions, & Activation States

The Origins of Mouse Tissue-Resident Macrophages Redefined

During development and throughout life, macrophages reside in many tissues of the body, contributing to both the maintenance and repair of tissues and the immune response. Emerging evidence suggests that in the liver, peritoneum, bone marrow, and spleen, macrophages can be classified into distinct populations based on their origin, function, and cytokine production profiles.

Markers, Origins, & Specialized Functions of Select Mouse Tissue-Resident Macrophages

- **Adipose Tissue**
  - Macrophages are recruited to adipose tissue following injury or inflammation, playing a role in fat metabolism and energy homeostasis.

- **Blood**
  - Macrophages are present in the bloodstream, contributing to immune surveillance and clearance of pathogens.

- **Bone**
  - Macrophages in bone marrow are involved in hematopoiesis and immune regulation.

- **Central Nervous System**
  - Macrophages in the brain and spinal cord contribute to immune surveillance and the maintenance of the blood-brain barrier.

- **Gastrointestinal Tract**
  - Macrophages in the gut play a key role in immune surveillance and the regulation of gut microbiota.

- **Liver**
  - Macrophages in the liver are involved in immune regulation, lipid metabolism, and the clearance of pathogens.

- **Lung**
  - Macrophages in the lung contribute to immune surveillance and the maintenance of lung function.

- **Skin**
  - Macrophages in the skin play a role in immune surveillance, wound healing, and the regulation of tissue homeostasis.

- **Spleen**
  - Macrophages in the spleen are involved in immune surveillance and the regulation of hematopoiesis.

- **Spleen**
  - Macrophages in the spleen contribute to immune surveillance and the regulation of hematopoiesis.

- **Tumor Infiltration**
  - Macrophages can infiltrate tumors, influencing tumor growth and immune response.

- **Wound Healing and Tissue Remodeling**
  - Macrophages are crucial in the healing process, contributing to tissue repair and remodeling.

Models of Macrophage Activation

Classical/Alternative Model of Macrophage Activation

- **Classical Macrophage Activation**
  - Stimulated by pro-inflammatory cytokines (e.g., IL-1, TNF-α), leading to an inflammatory response characterized by the secretion of pro-inflammatory cytokines and chemokines.

- **Alternative Macrophage Activation**
  - Stimulated by anti-inflammatory cytokines (e.g., IL-10, TGF-β), leading to an anti-inflammatory response characterized by the secretion of anti-inflammatory cytokines and chemokines.

- **M2 Macrophage Activation**
  - Stimulated by M2 agonists, leading to an anti-inflammatory response characterized by the secretion of anti-inflammatory cytokines and chemokines.

- **M1 Macrophage Activation**
  - Stimulated by M1 agonists, leading to an inflammatory response characterized by the secretion of pro-inflammatory cytokines and chemokines.

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