Gene name: **IFNB1** **Previous HGNC Symbols for IFNB1 Gene:** IFNB

External Ids for IFNB1 Gene: HGNC: 5434 NCBI Gene: 3456 Ensembl: ENSG00000171855
OMIM®: 147640 UniProtKB/Swiss-Prot: P01574

NCBI Gene Summary: This gene encodes a cytokine that belongs to the interferon family of signaling proteins, which are released as **part of the innate immune response to pathogens**. The protein encoded by this gene belongs to the type I class of interferons, which are important for defense against viral infections. In addition, type I interferons are involved in cell differentiation and anti-tumor defenses. Following secretion in response to a pathogen, type I interferons bind a homologous receptor complex and induce transcription of genes such as those encoding inflammatory cytokines and chemokines. Overactivation of type I interferon secretion is linked to autoimmune diseases. Mice deficient for this gene display several phenotypes including defects in B cell maturation and increased susceptibility to viral infection.

GeneCards Summary: IFNB1 (Interferon Beta 1) is a Protein Coding gene. Diseases associated with IFNB1 include Multisystem Inflammatory Syndrome In Children and Secondary Progressive Multiple Sclerosis. Among its related pathways are Overview of interferons-mediated signaling pathway and SARS-CoV-2 Infection. Gene Ontology (GO) annotations related to this gene include *cytokine activity* and *type I interferon receptor binding*. An important paralog of this gene is IFNA2.

UniProtKB/Swiss-Prot Summary: Type I interferon cytokine that plays a key role in the innate immune response to infection, developing tumors and other inflammatory stimuli (PubMed:10049744, 10556041, 6157094, 6171735, 7665574, 8027027, 8969169). Signals via binding to high-affinity (IFNAR2) and low-affinity (IFNAR1) heterodimeric receptor, activating the canonical Jak-STAT signaling pathway resulting in transcriptional activation or repression of interferon-regulated genes that encode the effectors of the interferon response, such as antiviral proteins, regulators of cell proliferation and differentiation, and immunoregulatory proteins (PubMed:10049744, 10556041, 7665574, 8027027, 8969169). Signals mostly via binding to a IFNAR1-IFNAR2 heterodimeric receptor, but can also function with IFNAR1 alone and independently of Jak-STAT pathways (By similarity). Elicits a wide variety of responses, including antiviral and antibacterial activities, and can regulate the development of B-cells, myelopoiesis and lipopolysaccharide (LPS)-inducible production of tumor necrosis factor (By similarity). Plays a role in neuronal homeostasis by regulating dopamine turnover and protecting dopaminergic neurons: acts by promoting neuronal autophagy and alpha-synuclein clearance, thereby preventing dopaminergic neuron loss (By similarity). IFNB1 is more potent than interferon-alpha (IFN-alpha) in inducing the apoptotic and antiproliferative pathways required for control of tumor cell growth (By similarity). (IFNB_HUMAN,P01574)

Cellular localization: mostly in the extracellular region.
Full Name: *Interferon Beta 1 (IFN-β)*
Protein Type: Type I interferon cytokine

Biological Function of IFNB1

- IFNB1 encodes interferon beta-1, a central antiviral and immunomodulatory cytokine.
- Produced mainly by:
    - Fibroblasts (especially early during infection)

    - Epithelial cells
    - Monocytes/macrophages
    - Dendritic cells after pathogen detection
- Key biological actions:
    - Antiviral defense:
        - Induces an "antiviral state" in infected and neighboring cells by upregulating interferon-stimulated genes (ISGs).
    - Modulation of immune responses:
        - Promotes maturation of dendritic cells.
        - Enhances MHC class I expression to improve antigen presentation.
        - Activates natural killer (NK) cells and CD8+ T cells.
    - Regulation of inflammation:
        - Can both promote and limit inflammation depending on the context.

🛠️ Mechanism of IFNB1 Action:

- IFNB1 binds to the type I interferon receptor (IFNAR1/IFNAR2) on immune and non-immune cells.
- Activates the JAK-STAT signaling pathway:
    - Leads to STAT1/STAT2 phosphorylation.
    - Induces transcription of hundreds of ISGs.
- Downstream ISGs promote:
    - Antiviral activity (like, PKR, OAS)
    - Apoptosis of infected cells
    - Inflammatory cytokine modulation

🦠 Role of IFNB1 in Sepsis

- Early during infection, IFNB1 is rapidly upregulated upon detection of:
    - Bacterial components (such as, LPS via TLR4, TLR9).
    - Viral components (such as RNA viruses via RIG-I, MDA5 pathways).

- Dual role in sepsis:

    - Protective role:
        - Promotes early pathogen clearance by activating immune cells.
        - Enhances barrier function of epithelial tissues.

    - Pathogenic role:
        - Excessive or prolonged IFNB1 activation can lead to:
            - Immunosuppression
            - T cell exhaustion
            - Worsened cytokine storm
            - Increased risk of secondary infections

📈 Clinical Relevance of IFNB1 in Sepsis

Diagnostic Role:

- Type I IFN signatures, driven largely by IFNB1 and IFNA family members, can help distinguish infectious sepsis from non-infectious inflammatory conditions.

Prognostic Role:

- High IFNB1 expression levels correlate with:
  - Immune dysfunction
  - Greater risk of septic shock
  - Higher mortality
- A "high IFN signature" often marks patients who fail to recover immune competency.

Therapeutic Interest:

- Targeting IFNAR signaling (which responds to IFNB1) is being studied to modulate hyperinflammation in:
  - Severe bacterial sepsis
  - Sepsis-induced immune paralysis

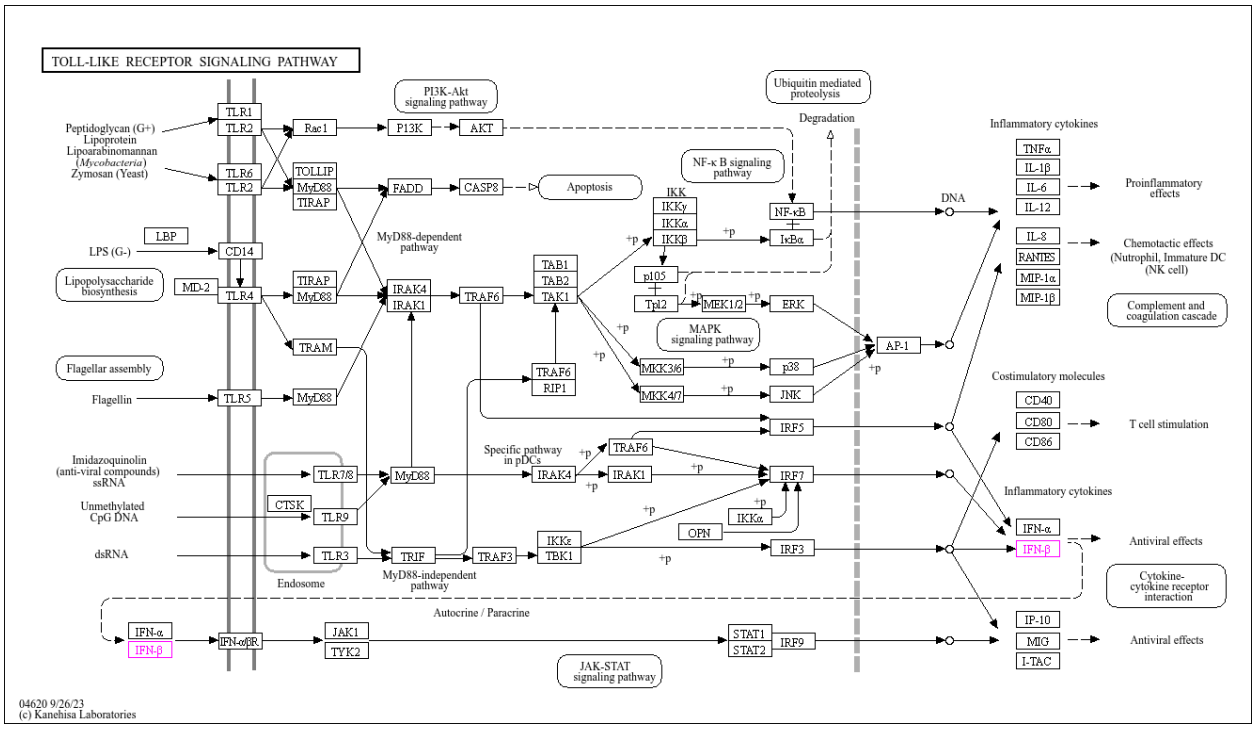
🔬 Pathways Involving IFNB1

- **JAK-STAT signaling pathway (hsa04630)** → classical pathway for type I interferons
- **RIG-I-like receptor signaling pathway (hsa04622)** → detects viral RNA, induces IFNB1
- **Toll-like receptor signaling (hsa04620)** → TLR4 and TLR9 can trigger IFNB1 production
- **Cytokine-cytokine receptor interaction (hsa04060)** → communication across the immune network

🧪 Supporting Literature

doi: 10.3389/fimmu.2017.00493
doi: 10.1016/j.jaut.2017.03.008

KEGG:



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