Unified GVF Framework Document

Abstract
Biological systems adapt via the Generator–Validator–Filter (GVF) cycle, a recurrent architecture across immunity, neurodevelopment, embryogenesis, cancer control, microbiome assembly, and evolution.

1. Introduction
Biological systems cannot rely on preprogrammed solutions; instead they generate variability, validate it, and filter failures.

2. GVF Architecture
G produces possibilities, V evaluates them, F removes non-viable states, enabling adaptive robustness.

3. Instances Across Biology
Immune system, neural development, embryogenesis, cancer control, microbiome, evolution.

4. Evolution as Meta-GVF
Evolution itself is a GVF system producing other GVF systems in fractal recursion.

Conclusion
GVF is a universal computational pattern recurring across biological scales.
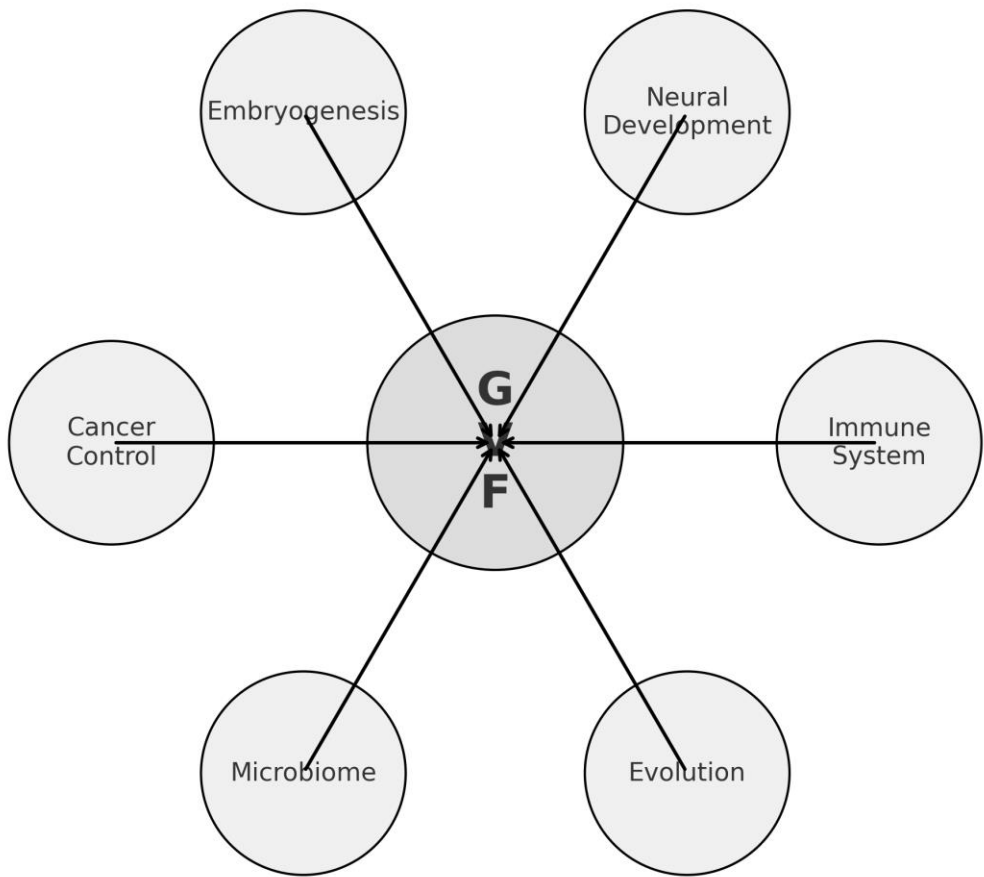
Figure 1. GVF Unified Circular Diagram

Table 1. Comparative GVF Architecture Across Systems

System	Generator (G)	Validator (V)	Filter (F)	Timescale
Immune System	V(D)J recomb. Somatic hypermutation	Antigen binding	Clonal deletion	Hours–Days
Neural Development	Synaptic overprod.	Activity validation	Microglial pruning	Days–Years
Embryogenesis	Cell proliferation	Morphogens	Apoptosis sculpting	Hours–Weeks
Cancer Control	DNA replication	Checkpoints	Senescence/apoptosis	Minutes–Days
Microbiome	Colonization	Nutrient competition	Immune filtering	Continuous
Evolution	Mutation/recomb.	Selection	Extinction	Millions of years