**Summary of Idea**

**Temporal-Uncertainty Biomedical Knowledge Graph** that captures:

* **Temporal evolution** of scientific facts (how/when knowledge is accepted or challenged).
* **Uncertainty modeling** (confidence levels: hypothesis vs. fact).
* **Contradictions and competing theories**.

**Technical Details**

**Deep Learning (NLP with Transformers)**

* **What to use**: BioBERT, SciBERT, PubMedBERT, Longformer (for long scientific texts).
* **Use case**: Extract subject-relation-object triples along with temporal context (*e.g., “In 2012, Drug X was found to inhibit Protein Y”*).

**RAG (Retrieval-Augmented Generation)**

* **What to use**: Combine vector search (like FAISS) with LLMs (e.g., OpenBioGPT).
* **Use case**: On-demand citation-supported summaries of evolving biomedical facts, and to highlight contradictions or shifts in interpretation.

**Knowledge Graphs (Temporal + Uncertain)**

* **What to use**:
  + **Temporal KGs**: t-KGE models, Know-Evolve, ChronoKG.
  + **Uncertainty-aware KG models**: Probabilistic embeddings (e.g., BoxE, KG-BERT with uncertainty).
* **Use case**: Represent each biomedical claim with:
  + Timestamp(s) of support.
  + Confidence level (learned from citation frequency, sentiment in abstracts) + NLP to classify how certain the authors are based on explicit modal verbs (e.g., “suggests”, “confirms”, “might”)).

**Citation Network Analysis**

* **What to use**: Graph neural networks (e.g., Heterogeneous GNNs), PageRank over PubMed citation graph.
* **Use case**: Map influence or emergence of consensus.

**Contradiction Detection Using LLMs**

* Use fine-tuned LLMs to highlight opposing statements between papers *("X increases Y" vs. "X does not affect Y"*).

**User-Defined Query Paths**

* Let users ask: “*How did understanding of Alzheimer’s Protein X evolve from 2000 to 2023?*” → Show timeline + evidence trail.