

## BioLens

*Visualising COVID-19 from Global Spread to Human Impact*

### Goal

The goal of this project is to develop an **Augmented Reality-based immersive analytics system** that allows users to explore the multi-scale dynamics of COVID-19, from global spread to human anatomy and molecular interactions of the virus.

Specifically, the project aims to:

- Visualize global spread of COVID-19 and evolution of variants over time.
- Demonstrate infection effects on human organs
- Explain virus structure and mutations to connect molecular changes with real-world impact.
- The system enables **interactive and immersive exploration in AR** for education, research, and data analysis.

### Where 3D Visualization Can Be Helpful:

- **Global Spread:** Animated 3D globe with infection hotspots and variant spread.
- **Human Anatomy:** Volume-rendered lungs and organs showing infection progression.
- **Molecular Biology:** 3D virus particle visualization with spike protein mutations.
- **Education:** This system allow learners to walk around and study complex systems spatially.
- **Analytical Insights:** Users can compare mutation impacts, infection severity, and geographic spread simultaneously.

### Which 2D Visualizations Can Work Better In 3D:

2D Visualization	3D Enhancement	Reason
Line charts (infection over time)	Animated 3D timeline on globe	Time-series data can be explored spatially on Earth.
Heatmaps (case density)	3D heatmap on rotating globe	Users can see global clusters in context.
Scatterplots (mutation vs. transmissibility)	3D molecular cluster	Walk around mutation clusters and explore connections.
Organ-level bar graphs (viral load by organ)	Overlaid on 3D anatomy	Makes spatial relation of infection clear.
Network diagrams (variant evolution)	3D node-link structure	Easier to perceive branching and clustering.

## Used Device

- **Tablet:** ARKit / ARCore compatible.
- **Smartphone:** Android / iOS.
- **Optional:** AR headset (Apple Vision Pro, Meta Quest 3).

## Dataset and Format

Data Type	Format	Source
COVID-19 Global Cases	CSV / JSON	Johns Hopkins University COVID-19 Repository
Viral Variants and Mutations	FASTA / CSV	GISAID
Human Anatomy Models	3D Volume Data (DICOM / OBJ / glTF)	Visible Human Project, Sketchfab
Virus Structure	PDB / OBJ / glTF	RCSB Protein Data Bank
Epidemiological Graph Data	CSV / JSON	WHO / National Health Datasets

## Visualization Techniques

Visualization Level	Technique	Description
Global	3D Globe with Heatmap	Infection hotspots, transmission arcs, animated time-series.
Human Anatomy	Direct Volume Rendering	Shows lung infection, organ-level viral load, immune response.
Molecular	Molecular Surface Rendering / 3D Node-Link	Visualizes spike proteins, receptor binding, mutation clusters.
Analytics Overlay	Floating Panels / Charts	Line, bar, and radial charts overlaid in AR space.
Interaction	AR Gestures, Touch, Pinch-Zoom	Explore, select, and scale models in real space.

## Mockups

### Scene 1: Global Spread

- Globe on desk with red heatmaps for infection.
- Timeline slider on side.
- Small pop-up panels with stats.

## Scene 2: Human Body Impact

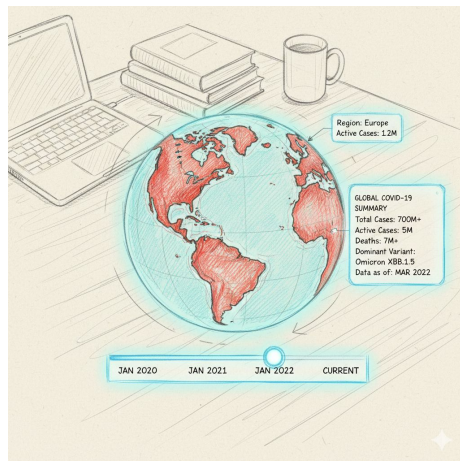
- Semi-transparent body floating in AR space.
- Red highlights on lungs and affected organs.
- Virus particles and immune cell animation.
- Floating panels with viral load, oxygen saturation.

## Scene 3: Molecular Interaction

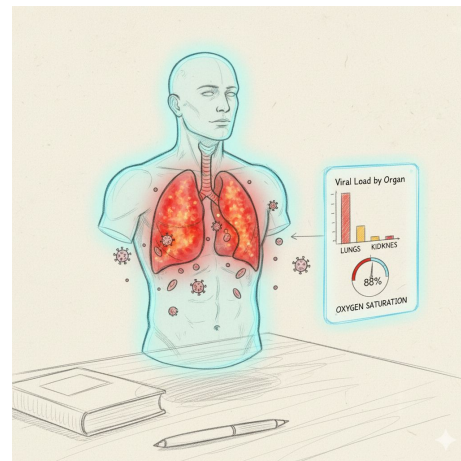
- 3D virus particle with spike proteins.
- Close-up of spike protein binding to ACE2 receptor.
- Annotation panels showing mutation info and effects.

## Scene 4: Multi-Scale Connection

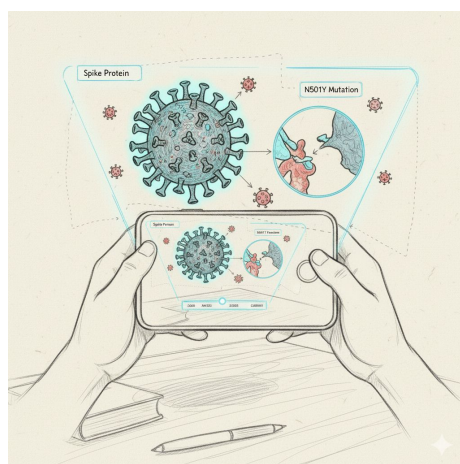
- Mini-globe + human body + virus particle side by side.
- Connecting lines showing relationships between global, anatomical, and molecular levels.



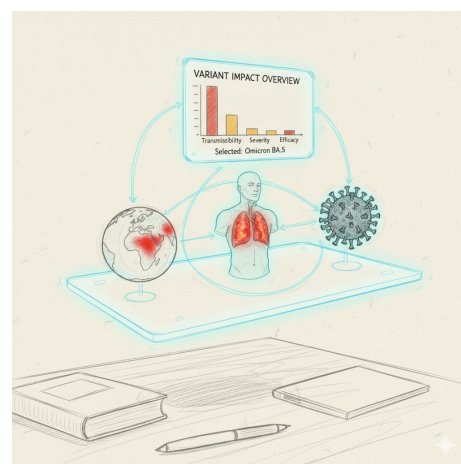
*Img 1: Global Spread*



*Img 2: Human Body Impact*



*Img 3: Molecular Interaction*



*Img 4: Multi-Scale Connection*

Img Reference : *Google Gemini*