GluPro: Diagnosing Neonatal Meningitis

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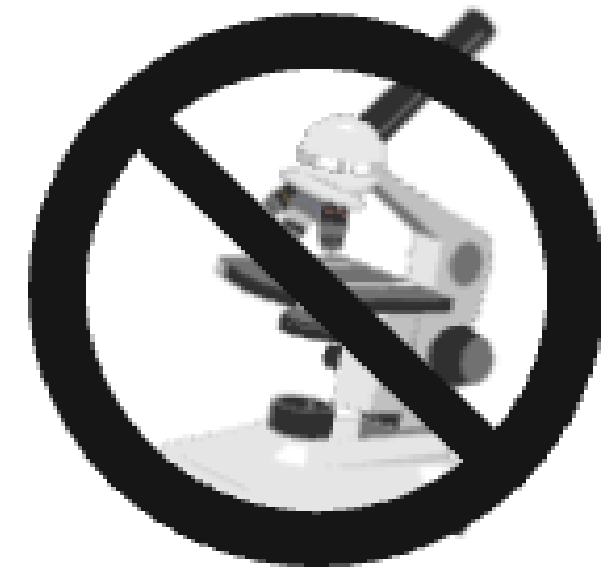OEDK Oshman Engineering Design Kitchen

References

MENINGITIS DISEASE BURDEN

- **54%** death rate in Malawi
- Over **24 hours** for results
- **3-6 hour** delays associated with death

CURRENT SOLUTIONS

- Lack of equipment
- Long wait times
- Personnel shortages
- Financial barriers
- Transportation issues

- Dangerous outcomes
  - Hearing loss
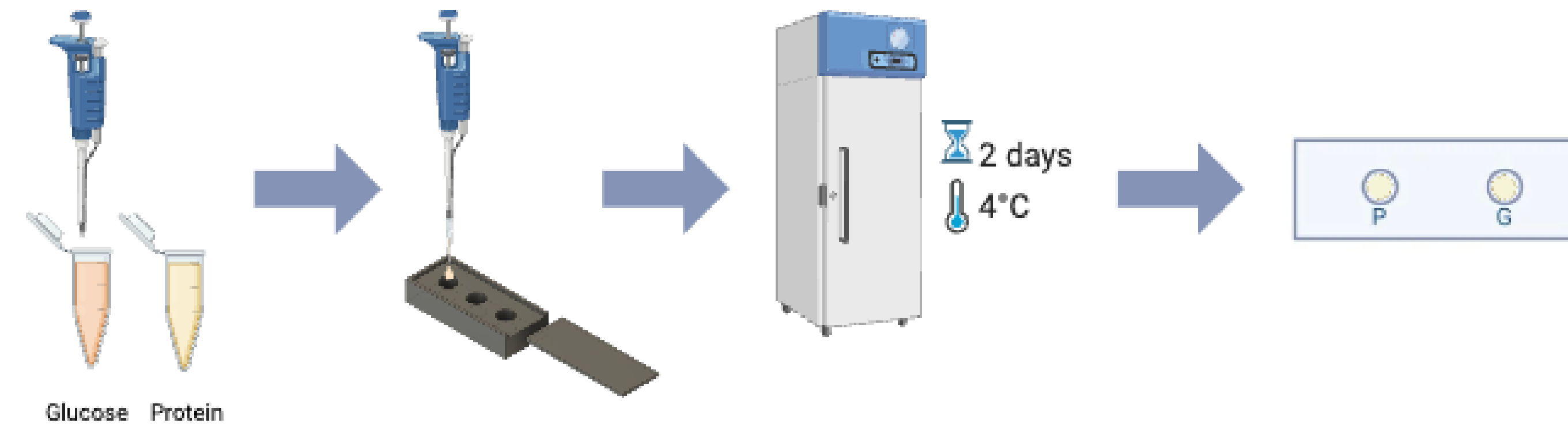 - Balance issues
  - Seizures

PROBLEM STATEMENT

We aim to create an **accurate, easy-to-use, rapid** measurement device for **glucose** and **protein** quantification to aid in diagnosis of neonatal meningitis.

DEVICE FEATURES

- ☑ Quantitative color mapping
- ⏱ Results within 10 minutes
- 🎨 Expanded color detection range
- 💲 <$1 per test materials cost
- 👆 Simple 2-component system
- 💪 Stable at room temperature

MANUFACTURING PROCESS

⏳ 2 days
🌡 4°C

Glucose   Protein

PRODUCT USE WORKFLOW

SPINAL TAP → CSF SAMPLE → DROPLET ON TEST SLIDE → COLOR CHANGE → PICTURE ON APP → RESULTS

GLUCOSE: ?? mg/dL
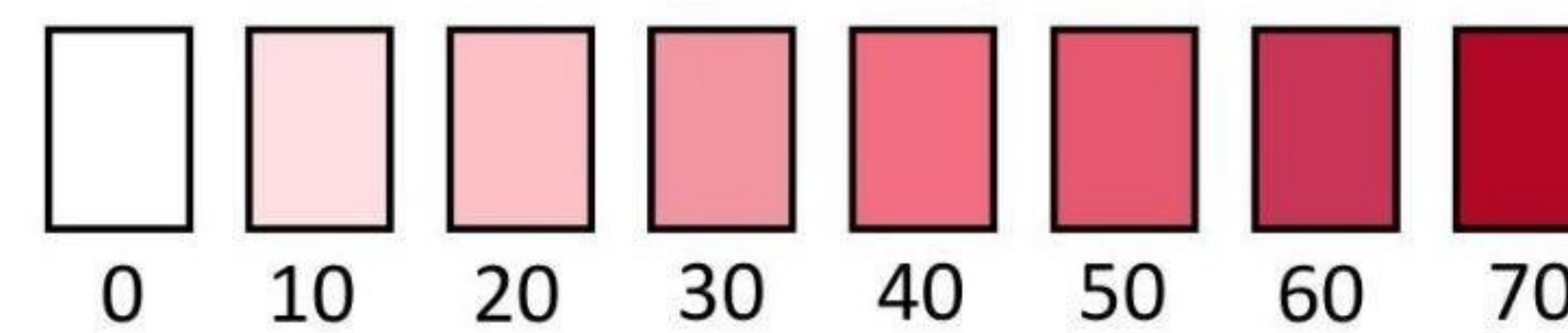PROTEIN: ?? g/L

GLUCOSE

- **Lower** levels in neonatal meningitis at **<30 mg/dL**
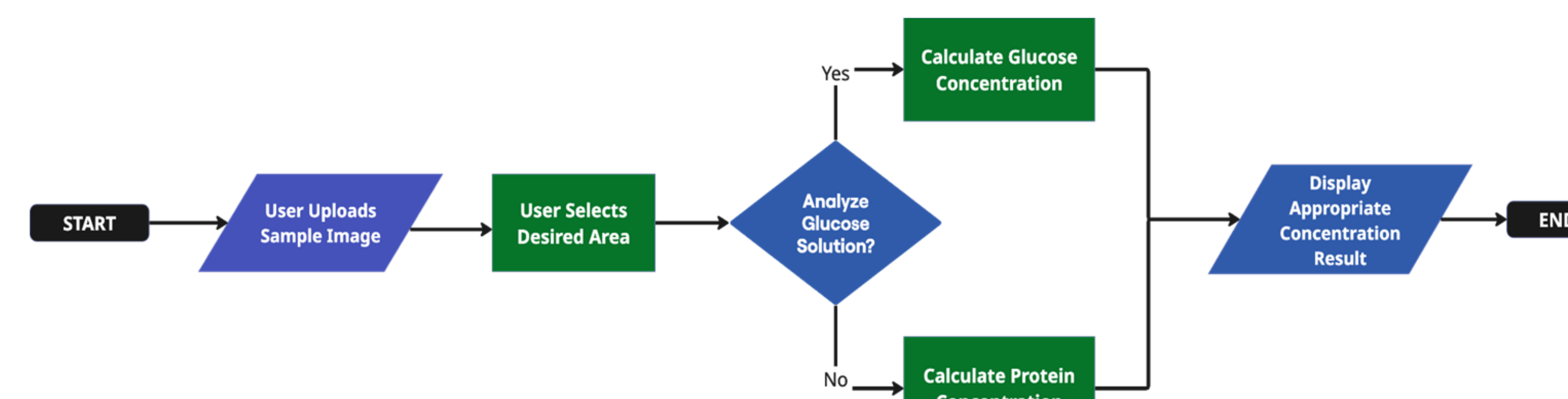- **5X** original reagent concentrations to narrow range

GOD-POD Reaction:

Glucose + Glucose Oxidase + Peroxidase + Phenol + 4-AP

↓

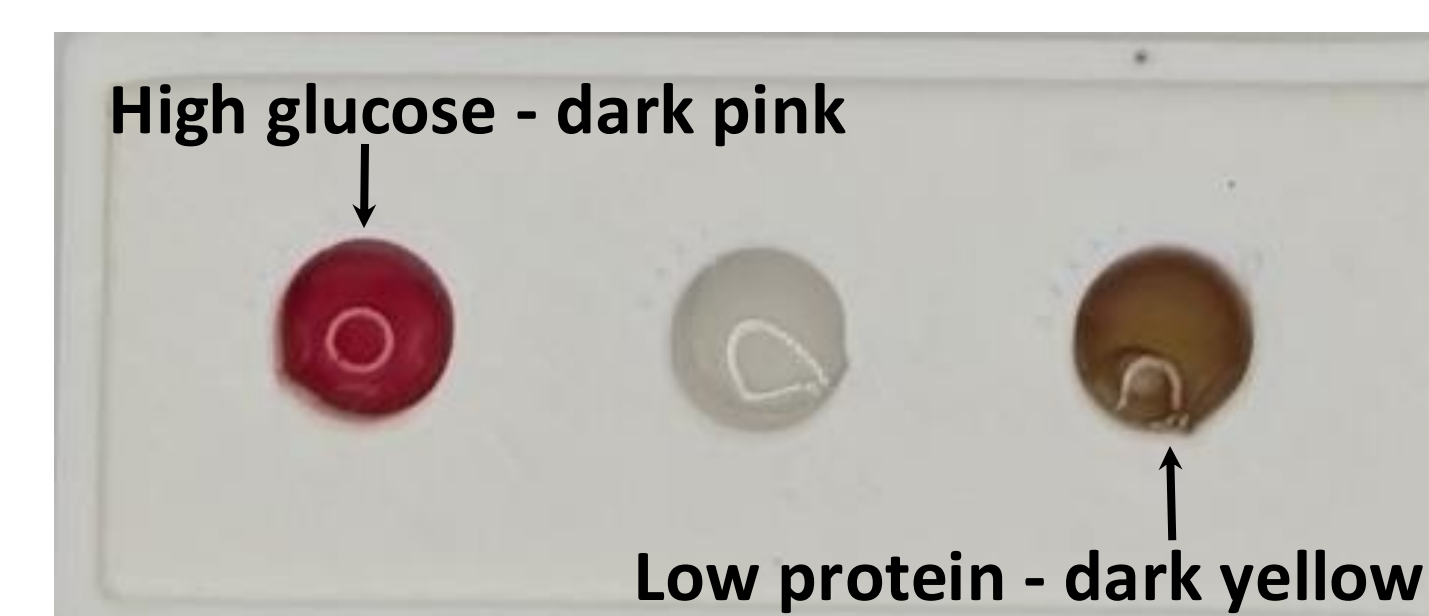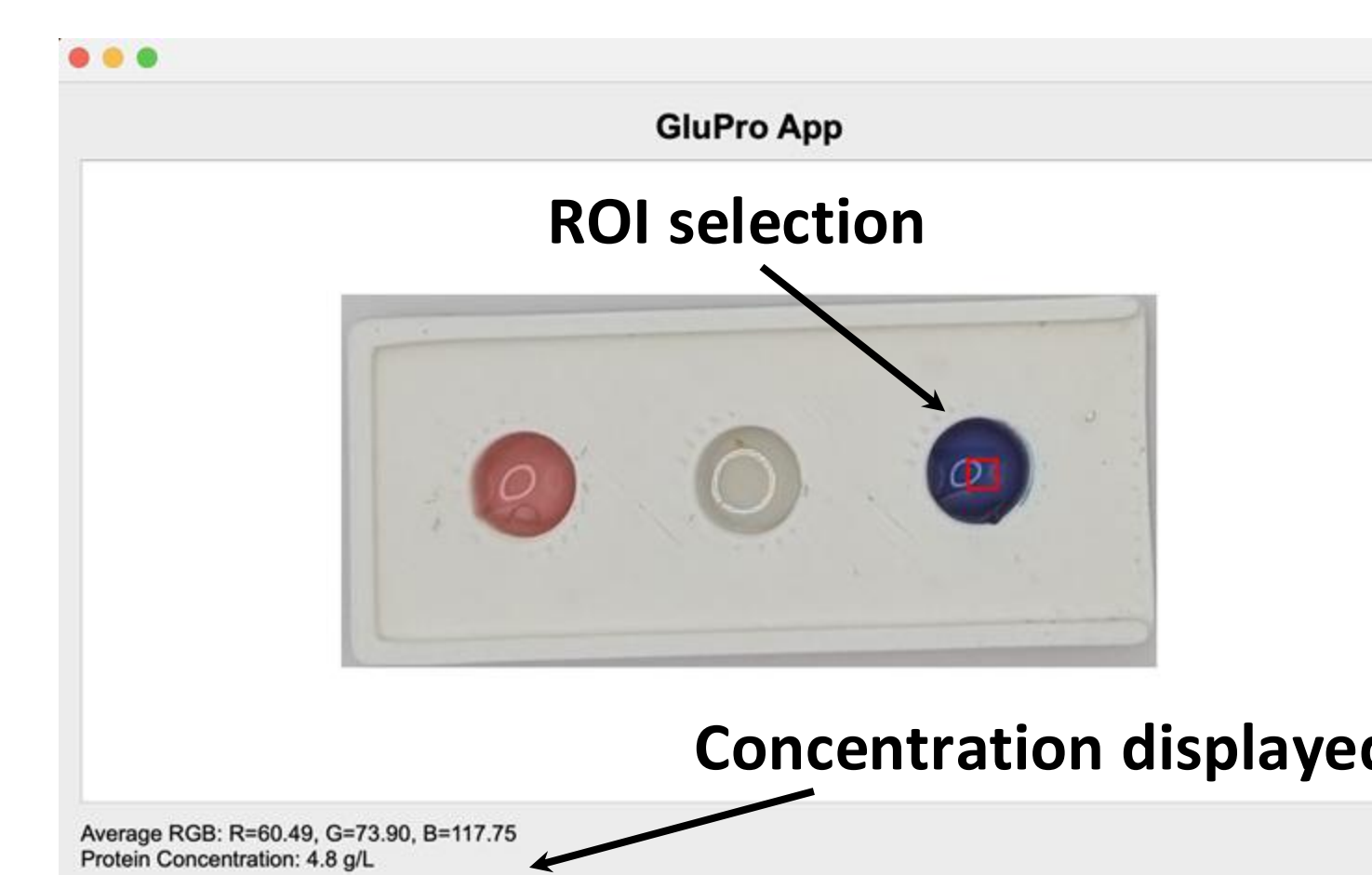**Pink Color Develops**

Glucose Color Chart (mg/dL)

0 10 20 30 40 50 60 70

DIGITAL APP

START → User Uploads Sample Image → User Selects Desired Area → Analyze Glucose Solution? → Yes → Calculate Glucose Concentration → Display Appropriate Concentration Result → END

Analyze Glucose Solution? → No → Calculate Protein Concentration

SAMPLE TESTS

Healthy Test Result

High glucose - dark pink
Low protein - dark yellow

Meningitis Test Result

Low glucose - light pink
High protein - dark blue

GluPro App

Select Measurement

Would you like to measure Glucose or Protein?

Glucose

Cancel   OK

Selection of desired variable

GluPro App

ROI selection

Concentration displayed

Average RGB: R=60.49, G=73.90, B=117.75
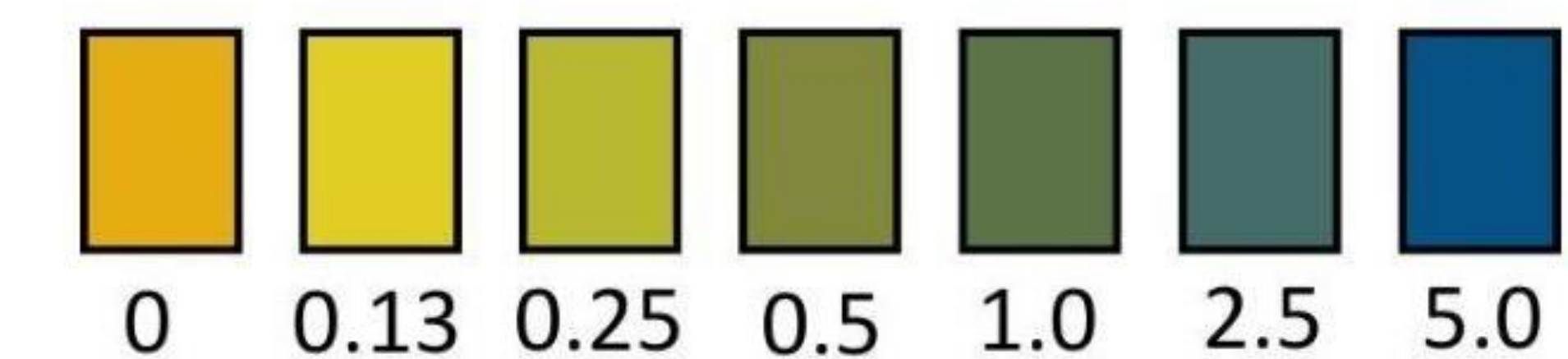Protein Concentration: 4.8 g/L
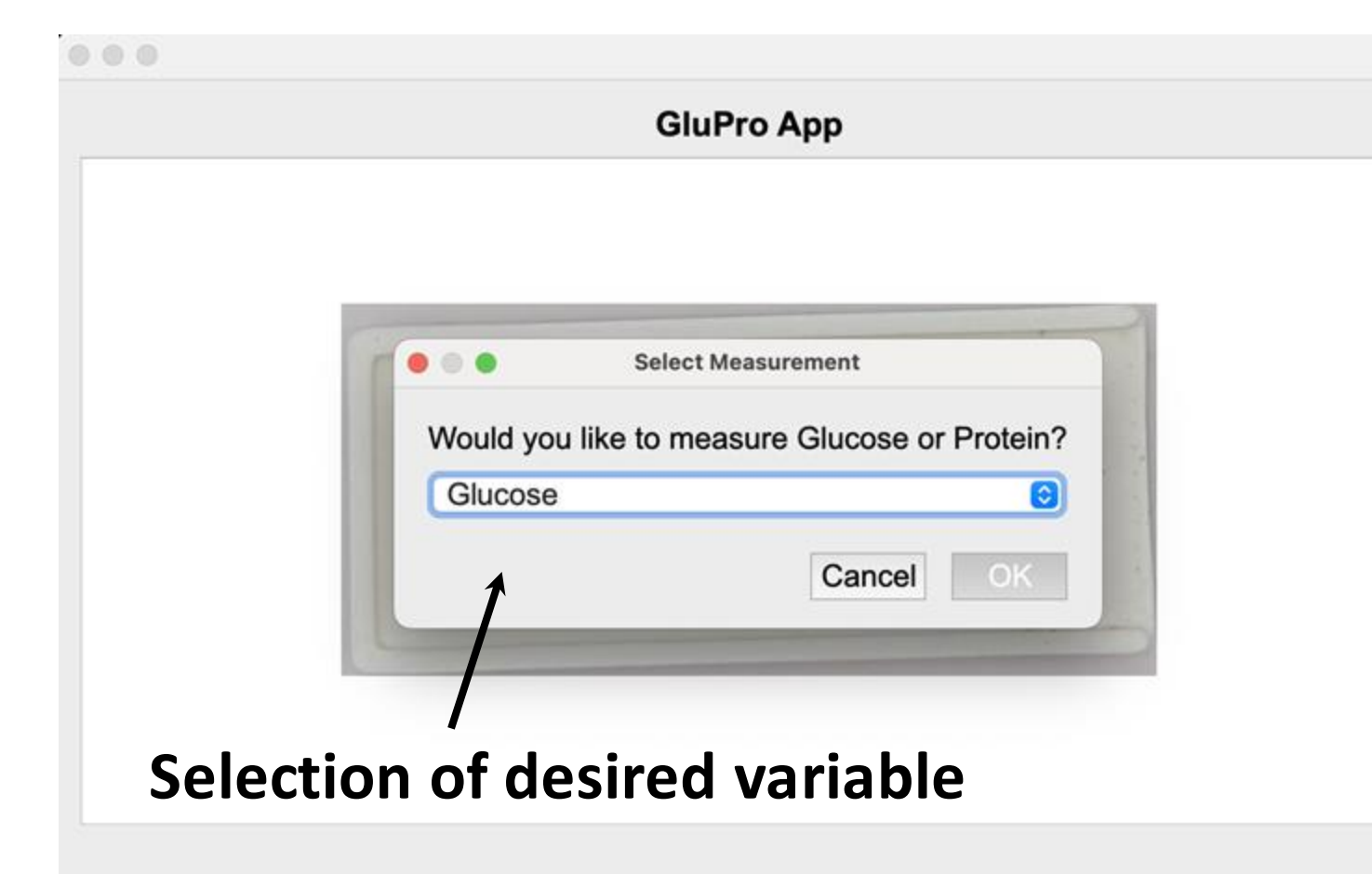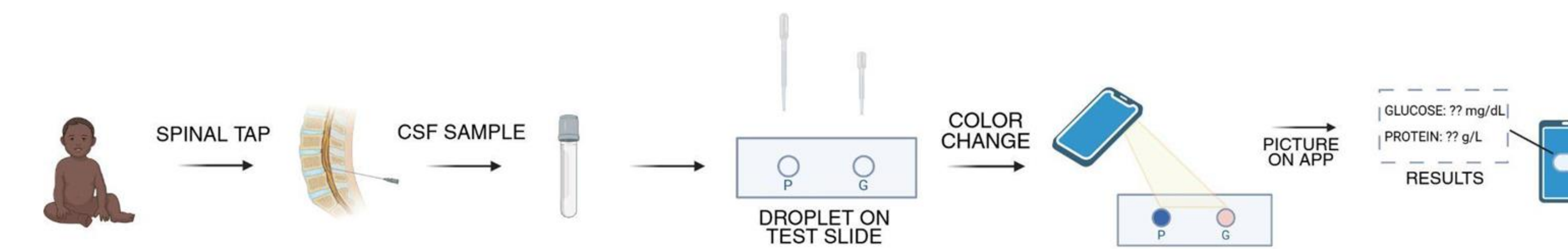
PROTEIN

- **Higher** levels in neonatal meningitis at **>1.5 g/L**
- **60%** dilution of tetrabromophenol blue and **pH of 3** to expand range

Tetrabromophenol-Blue Reaction:
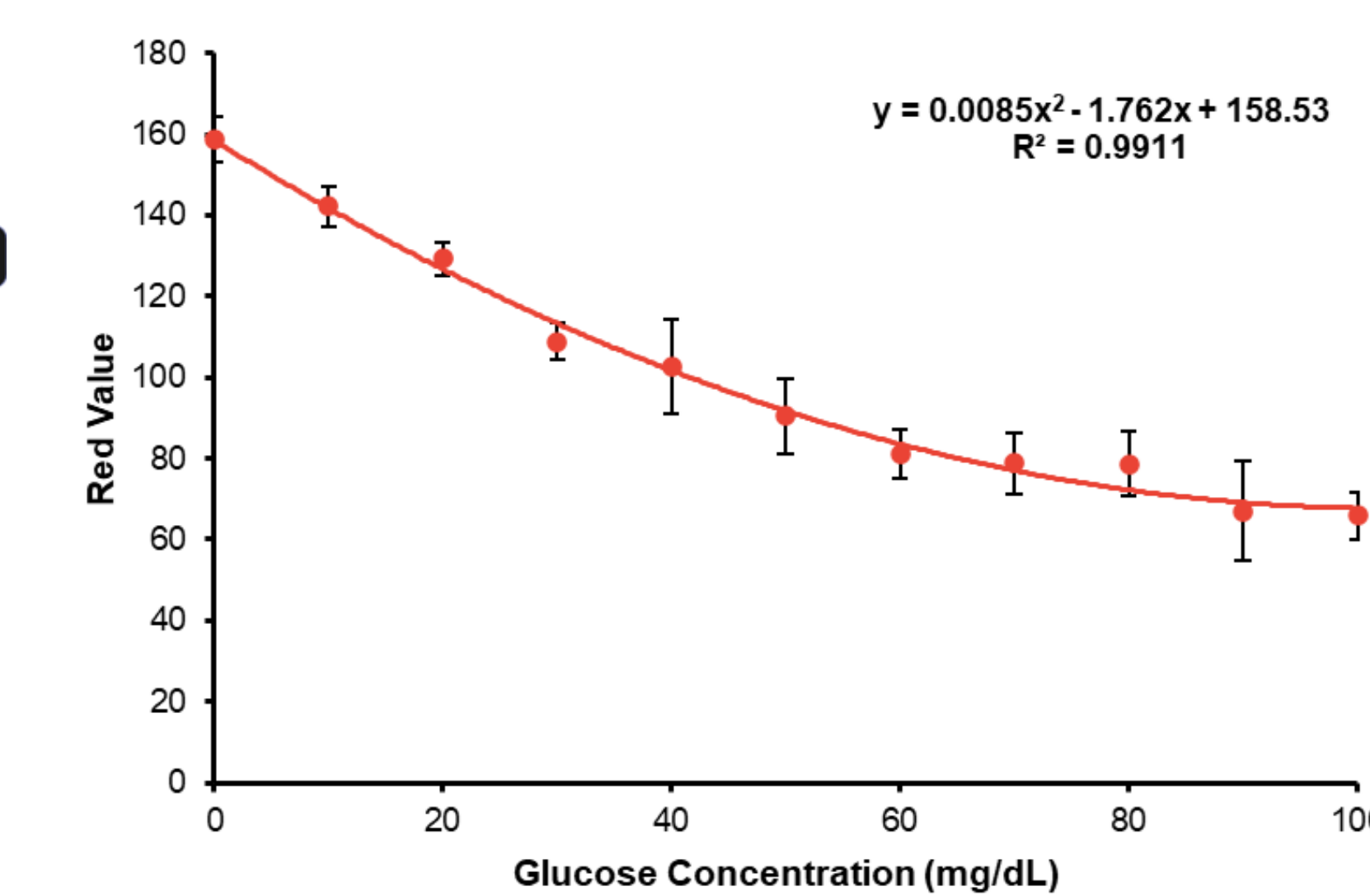
Protein + Tetrabromophenol Blue + HCl
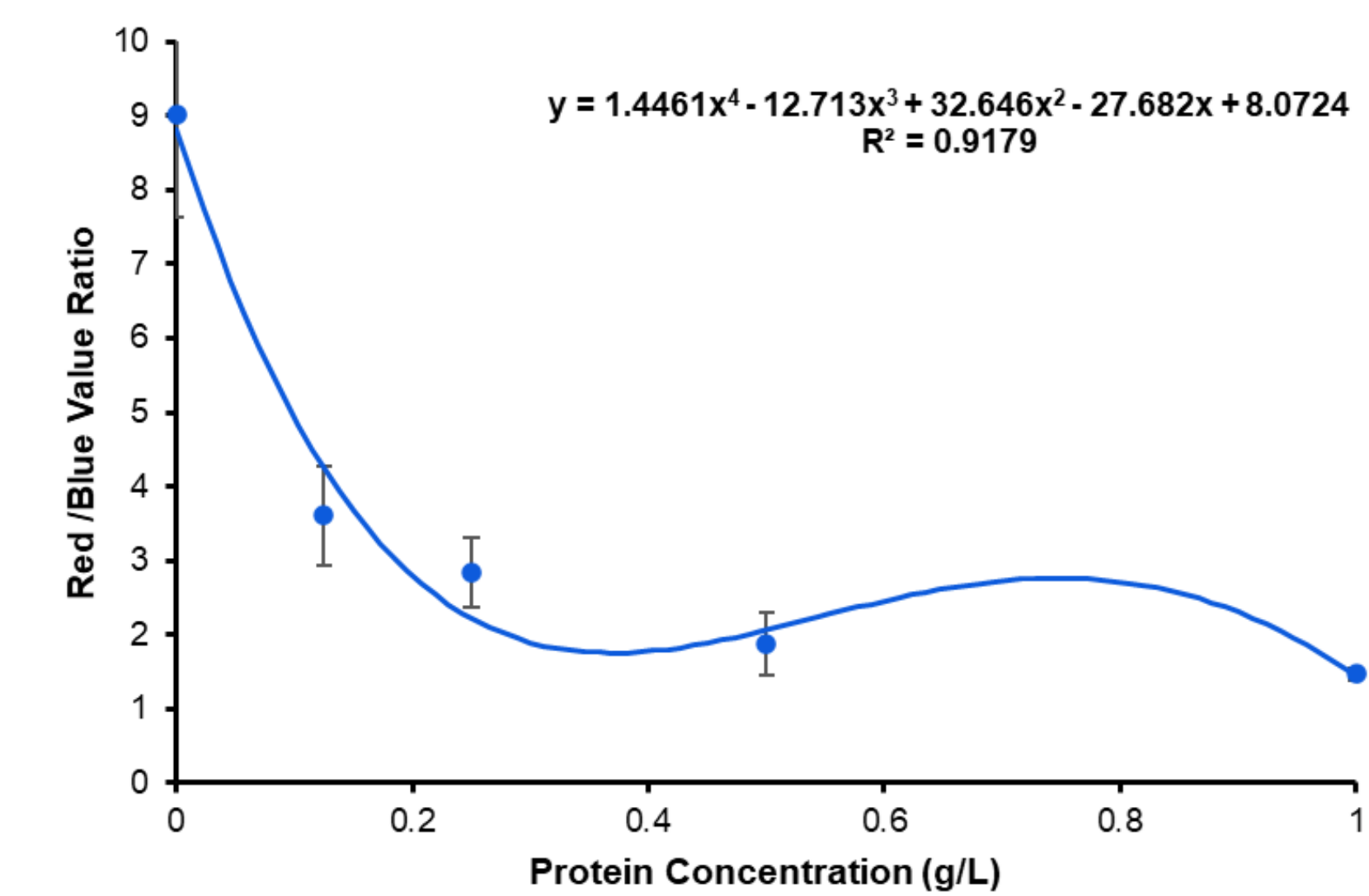
↓

Blue Color Develops

Protein Color Chart (g/L)

0 0.13 0.25 0.5 1.0 2.5 5.0

PREDICTIVE REGRESSION MODELS

Predicting Glucose Concentration using RGB Data

$y = 0.0085x^2 - 1.762x + 158.53$
$R^2 = 0.9911$

Red Value (y-axis): 0, 20, 40, 60, 80, 100, 120, 140, 160, 180
Glucose Concentration (mg/dL) (x-axis)

Predicting Protein Concentration using RGB Data

$y = 1.4461x^4 - 12.713x^3 + 32.646x^2 - 27.682x + 8.0724$
$R^2 = 0.9179$

Red /Blue Value Ratio (y-axis): 0 to 10
Protein Concentration (g/L) (x-axis): 0, 0.2, 0.4, 0.6, 0.8, 1

IMPACT ON MENINGITIS

- Functional test that **distinguishes high & low** glucose and protein levels
- Improved treatment **timeframe**
- **Standardized** color assessment
- Future work
  - Validation with CSF samples
  - AI-based quantitative analysis

ACKNOWLEDGEMENTS