

***Preliminary Design Specifications***  
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pH Monitor for *In Vitro* Bovine Embryo Incubation Labs

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**Client:**

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**Design Statement:** To design a device to measure the pH of approximately 20 – 50  $\mu\text{L}$  of CR1 media surrounding *in vitro* cultured bovine embryos. The testing must occur within a CO<sub>2</sub> humidity controlled incubator. The data collection must occur without modification of the incubator.

**Client Requirements:**

- Does not interact with or disturb the embryos
- Does not alter the existing incubator
- Accurate to one tenth of a pH unit

**Design Requirements:**

**Performance:** The pH meter will obtain continuous readouts of bathing media surrounding *in vitro* bovine embryos. The device must not interact with or disrupt the embryos. The readings must be accurate to the tenth of a pH unit. The measured pH will also reflect the average pH of the bathing media. The device will take readings from cultures held in a CO<sub>2</sub> incubator and will either fit inside the incubator, or have leads that run into the incubator (without inhibiting or changing the incubator).

**Safety:** The device will be properly insulated to avoid undesired electric discharge. The entire device, or the section in contact with the bathing media, can be sterilized to avoid contamination of the embryos.

**Accuracy and Reliability:** The device will continuously measure pH between 5 and 9 with accuracy to a tenth of a pH unit. Stand adjustment must be accurate enough to allow correct positioning of pH probe in order to record the desired pH.

**Life in Service:** The meter will be used long enough to obtain a reliable reading, and readings will be recorded at least daily during embryo growth cycle.

**Shelf Life:** The device will function for a comparable pH meter lifetime (~2 to 10 years).

**Maintenance:** The pH meter must be calibrated on a regular basis (~bimonthly). Calibration includes testing and resetting the meter in correspondence with the pH of known solutions (i.e. 5, 7, and 9). The cables and connections of the meter will be checked regularly (~annually). The device must be sterilized between each use (~ethanol wash, disposable sections, autoclave, etc.).

**Operating Environment:** The operating environment is a lab setting. The incubator is approx. 3' x 2'6" x 3'. The incubator is held constant at 5% CO<sub>2</sub> and 35 degrees C.

**Ergonomics:** Controls for the pH probe stand should be user-friendly for adjustments.

**Size:** The pH meter and stand need to fit inside the incubator (dimensions given above). The pH probe tip must be small enough to measure the microvolumes of media.

**Materials:** The section of the device in direct contact with the media will be composed of materials that will not alter the bathing media or interact with the embryos. All components within the incubator must be able to withstand the environmental conditions.

**Quantity:** The client requires only one device for the time being.

**Target Product Cost:** Costs over the BME budget must be approved by client. Estimating around \$1,000 for all project components.

**Standards and Specifications:** The device must be approved by Dr. Duello and must be tested extensively as to determine if there is any interaction with the media or the embryos.

**Customer:** The client (Dr. Duello) suggested the idea of a small microprobe in measuring the pH levels. She stated that the ideal meter would read the pH within the embryo, but the pH in the surrounding media would be sufficient. She would like the meter to make the reading within the incubator as to avoid moving and possibly traumatizing the embryos. The type of dish that the embryos are cultured in is variable and the client even suggested that another shape of culture dish might prove easier to make a measurement in. She initially specified that the device must not alter the incubator's function/performance in any way. Later she approved a cord exiting the incubator running under the bottom of the door.

**Competition:** There are many existing methods for measuring pH levels in solution. There are devices commercially available for these methods.