**Protocol for measuring mitochondrial function and CORT from pilot *delicata* – by OC 10/03/2023**

**Good resources here:** [**https://www.agilent.com/en/product/cell-analysis/how-to-run-an-assay**](https://www.agilent.com/en/product/cell-analysis/how-to-run-an-assay)

**Background:** High CORT treatment reduces body size in hatchling and juvenile skinks.

**Hypotheses:** We will test two mechanisms to explain differences in body size.

1) Treatment with CORT *in ovo* programs HPA axis such that lizards exposed to the high CORT treatment have higher levels of baseline CORT at hatching and as juveniles. For these effects to be programmatic, we should be able to detect them into adulthood.

2) Developmental CORT treatment reduces the efficiency of liver mitochondria. The liver has an important role in gluconeogenesis. Decreased efficiency of liver mitochondrial function would explain why lizards exposed to CORT *in ovo* hatch at a smaller body size.

These hypotheses are potentially related. For example, if developmental CORT treatment has programmatic effects on HPA axis and there is a correlation between baseline CORT and liver mitochondrial function, this would explain the continued effects of developmental treatment on body size (i.e., they grow slower and potentially achieve a smaller adult body size). However, if there are no effects of developmental treatment on adult baseline CORT, but there are effects on liver mitochondrial function (for example), this suggests that there are programmatic effects of developmental treatment on mitochondria, but that these effects are not being regulated indirectly through changes in the HPA axis.

**Project objectives:**

**1) Measure baseline CORT levels – priority**

**2) Measure mitochondrial function in liver tissue – priority**

**3) Measure body size and mass** – **priority;** we need a final body size measurement which will give us n= 4 measurements from hatching onward.

**4) Sex lizards** – **priority;** we need to sex all the lizards for analyses. Apparently, this can be done after they are euthanized, and tissues are removed.

**Timeline:**

1. **Book Seahorse well in advance.**
2. **The day before the assay**
   1. Prepare PBS and mitochondria buffer stock solutions if needed (except pyruvate which should be made the day of the assay).
   2. Hydrate Seahorse sensor cartridge the night before the assay (see below).
3. **The day of the assay**
   1. Change the temperature of the Seahorse to 30°C.
   2. Prepare mitochondria stress chemicals prior to euthanizing animals. Keep on ice or in refrigerator before use.
   3. Prepare mitochondria buffer prior to euthanizing animals. Keep on ice or in refrigerator before use.
   4. After euthanizing animals, make sure the centrifuges has been turned on and is chilled to 4°C before processing tissue samples.
   5. Save aliquot of processed homogenate after processing samples (see below).
   6. Run Seahorse assay.
4. **After the assay**
   1. Bradford assay
   2. CORT assay

**Recipes:**

1. **Phosphate buffered saline (PBS) - make before tissue collection**
   1. For 500 mL of 10X PBS: 8.9 g of Na2HPO4\*2H20 (100mM) + 1.2 g of KH2PO4 (18mM) + 40g of NaCl (1.37M) + 1 g KCl (27mM).
   2. For 1 L of 1X PBS: 100 ml of 10x PBS + 900ml of ddH2O
2. **Mitochondria buffer stock solutions - make before assays if needed**
   1. Glucose (1.0 M solution) – To make 25 ml

Molecular weight of glucose (anhydrous) = 180.16 g/mol

Concentration = 1.0 mol/L \* 180.16 g/mol

1M concentration = 180.16 g/L = 180.16 mg/mL

*To make 25mL:*

* + - 180.16 mg/mL \* 25 mL = 4,504 mg = 4.50 g
    - Combine 4.50 g of glucose with 25 mL of ddH20
    - Aliquot in 500ul and store at -20C
  1. Sodium Pyruvate (100 mM solution) – To make 1 mL

Molecular weight of sodium pyruvate = 110.04 g/mol

Concentration = 1.0 mol/L \* 110.04 g/mol

1M concentration = 110.04 g/L

1mM concentration = 0.11004 g/L

100mM concentration = 0.11004 g/L \* 100 = 11.004 g/L = 11.004 mg/mL

*To make 25mL:*

* + - 11.004 mg/mL \* 1 mL = 11.004 mg = 0.011 mg
    - Combine 0.011 mg of sodium pyruvate with 1 mL of ddH20
  1. L-glutamine (200 mM solution) – To make 25 mL

Molecular weight of sodium pyruvate = 146.14 g/mol

Concentration = 1.0 mol/L \* 146.14 g/mol

1M concentration = 146.14 g/L

1mM concentration = 0.14614 g/L

200mM concentration = 0.14614 g/L \* 200 = 29.228 g/L = 229.228 mg/mL

*To make 25mL:*

* + - 229.228 mg/mL \* 25 mL = 5730.7 mg = 5.7307 g
    - Combine 5.7307 g of L-glutamine with 25 mL of ddH20
    - Aliquot in 500ul and store at –20C

1. **Mito stress chemicals**
   1. **Stocks – make day of assay**
      1. Oligomycin – add 630 µl of media buffer to stock tube for **100 µM** **stock concentration.**
      2. FCCP – add 720 µl of media buffer to stock tube for **100 µM stock concentration.**
      3. Rot/antimycin A – add 540 µl of media buffer to stock tube for **50 µM concentration.**
   2. **Diluted stocks for assays – make day of assay.**
      1. Oligomycin – Testing four concentrations (2.0 uM, 1.5 uM, 1.0 uM, and 0.5 uM); these are the concentrations in the final well, the solutions are made at 10x this concentration as determined by the following dilutions (not that a larger volume of 1.0 uM/10 uM is needed for this particular optimization):
         1. 2.0 uM/20 uM = 600 ul of stock to 2300 ul of media
         2. 1.5 uM/15 uM = 2250 ul of 2.0 uM/20 uM + 750 ul of media
         3. 1.0 uM/10 uM = 2000 ul of 1.5 uM/15 uM stock to 1000 ul of media
         4. 0.5 uM/5 uM = 750 ul of 1.0 uM/10uM stock to 750 ul media
      2. FCCP – To test 0.125, 0.25, 0.5, and 1.0 uM
         1. 1.0 uM: Add 300 ul of stock solution to 2,700 ul of media buffer.
         2. 0.5 uM: Add 1,500 ul of 1.0 uM solution to 1,500 ul of media buffer.
         3. 0.25 uM: Add 1,500 ul of 0.5 uM solution to 1,500 ul of media buffer.
         4. 0.125 uM: Add 1,500 ul of 0.25 uM solution to 1,500 ul of media.
      3. Rot/antimycin A – For final concentration of 0.5 uM
         1. Add 300 ul of stock solution to 2,700 of media.
2. **Mitochondria isolation buffer**
3. **Mitochondria respiration buffer – to make 50mL (enough for one plate); make day of assay**
   1. XF Base medium – 48.5 mL
   2. Glucose (1.0 M solution) – 500 µl
   3. Pyruvate (100 mM solution) – 500 µl
   4. L-glutamine (200 mM solution) – 500 µl

**Methods**

1. Body measurements, euthanasia, and tissue collection

1. Start a timer as soon as an enclosure is disturbed.
2. Inject animal with sodium pentobarbital (record time of injection)
3. Measure SVL, tail, and body mass
4. Euthanize lizard by decapitation
5. Trunk blood will be collected into heparinized microcapillary tubes. We will note the time as soon as the blood has been collected. The blood will be put into Eppendorf tubes and kept on ice until processing (see below). Ideally, we will collect ~100ul of blood.
6. The liver will be removed and processed (see below). We will record the time when the liver is removed.
7. Lizards will then be sexed by either palpitation or dissection to determine the presence or absence of hemipenes.

2. Blood processing (to obtain CORT for hormone assays)

1. Centrifuge blood at **7000 rpm for 7 minutes** to separate plasma from red blood cells.
2. Remove plasma, put in new Eppendorf tube, and store at -20°C. This plasma will be used to measure baseline CORT levels.

3. Liver processing – making homogenates and isolating cells (all this done on ice, cold temps, and using ice-cold buffers)

1. Remove whole liver from lizard.
2. Rinse in 1 mL of ice-cold phosphate-buffered saline (1X) in Eppendorf tube by putting liver in tube and taking it out again with forceps.
3. Place whole liver in Eppendorf tube in 1 mL mitochondria assay buffer on ice before transporting back to Robertson to process tissue.
4. Homogenize in Dounce homogenizer as follows:
5. Use assay buffer supplemented with glucose, l-glutamine, and sodium pyruvate
6. Rinse homogenizer with ice cold PBS 3x before use
7. Add liver and 1ml of ice-cold mitochondria buffer to homogenizer (keep Falcon tube of buffer on ice)
8. With homogenizer on ice, use three hand gentle hand passes to homogenize (upward motion more important than downward motion).
9. Transfer homogenate to clean Eppendorf tube and keep on ice.
10. Centrifuge tubes at **750 x g, 4°C for 10 minutes**
11. **Save the supernatan**t into a clean Eppendorf tube (mitochondria are in the supernatant)
12. **Centrifuge at 10,000 x g, 4°C for 5 minutes**. Take off and dispose of supernatant (**mitochondria are now in pellet**)
13. Resuspend in 1000 µl of mitochondria buffer using gentle up a down with pipette tip
14. Keep on wet ice until use in Seahorse assay

5. Measuring mitochondria function using the Seahorse

***The evening before the assay/day of tissue collection*** – hydrate the Seahorse XFe96 sensor cartridge

1. Add 200 µl of sterile water to each well on the calibrant plate
2. There must be no air bubbles. To dislodge air bubbles, gently raise and lower the sensor cartridge into the water in the calibrant plate several times.
3. Incubate the plate and cartridge overnight in a humidified incubator at 30°C (assay temperature) at atmospheric CO2.
4. Include a 50mL aliquot of the XF calibrant in the incubator

*Preparing mitochondria medium*

1. Prepare 10 mL of supplemented media (recipe above). The additions to base media are what is recommended for work with liver cells.
2. Incubate at 30°C (assay temperature) in a falcon tube.

*Preparing oligomycine*

*Preparing the tissue homogenate dilutions for Plate 1 of optimizations*

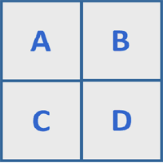
1. Need pooled samples to optimize oligomycin and tissue concentration
   1. Starting dilution is whole liver homogenate resuspended in 1000 ul (Dilution 1)
   2. After preparing liver homogenate for 6 livers, combine into a 15 mL Falcon tube (this is **Dilution 1**.
   3. **Dilution 2**: 2.5 mL of Dilution 1 + 2.5 mL of mitochondria buffer (1:2 dilution)
   4. **Dilution 3**: 2.5 mL of Dilution 1 + 2.5 mL of mitochondria buffer (1:4 dilution)
2. Need pooled sample to optimize FCCP assuming recommended oligomycin concentration of **1.0 uM** and assuming **Dilution 1** concentration of tissue homogenate.
   1. Will need 2.5 mL for FCCP titration so 3 livers
   2. After preparing liver homogenate for 3 livers, combine into a 15 mL Falcon tube.

*Preparing the culture plate with tissue homogenates*

1. Add 100 µl of tissue suspension to each designated well in the PVL coated culture plate. Sample order will be recorded on 96 well data sheet.
2. Fill blank (background) wells with 100 µl of media.
3. Centrifuge plate **at 200 g for 3 minutes on a low brake centrifuge setting** (es:3). This sticks the cells to the bottom of the plate.
4. Transfer to non-CO2 incubator at 28° C for 25 – 30 minutes. Visually inspect to see if cells have adhered.
5. Top up each well with 80 µl of warmed media for a total volume of 180 µl.

*Preparing compound* ***working*** *solutions – prepare solutions but do not load ports until getting to the JCSMR (volumes for each port listed here though)*

* Port A Oligomycin (for all final well concentrations)
  + **20 µl of working solution added to each port**
* Port B FCCP (for all final well concentrations)
  + **22 µl of working solution added to each port**
* Port C Rotenone/antimycin A (final well concentration 0.5 µM)
  + **25 µl of working solution to each port**
* Port D: N/A



*Before leaving for the JCSMR*

1. Replace the water in the wells of the sensor cartridge with 200 µl of calibrant solution.
2. Put the sensor cartridge back in the calibrant plate ensuring no air bubbles.
3. Bring with you:
   1. Sample plate
   2. Sensor cartridge
   3. Working solutions: 4 of Oligomycin, 4 of FCCP, and 1 of Rotenone/antimycin A
   4. Reagent reservoirs: need 9
   5. 25 ul multi-channel pipettes

*Loading working solutions into the ports of the sensor cartridge*

1. Cell culture microplate will have to be kept at 28°C in the JCSMR during calibration.
2. Load working solutions into ports at the JCSMR (to avoid walking with loaded cartridge between labs)
3. Use multi-channel pipette and reverse pipette to prevent air bubbles.

*Running the assay*

1. Set up file template ahead of time.
2. Place calibration plate with loaded sensor cartridge in instrument tray and click START. Calibration takes 15 – 30 minutes.
3. After calibration, load cell culture microplate and click I’m Ready.