

Developing a Steady Hand for Nanoscience

Eric W. Roth

Core Scientist

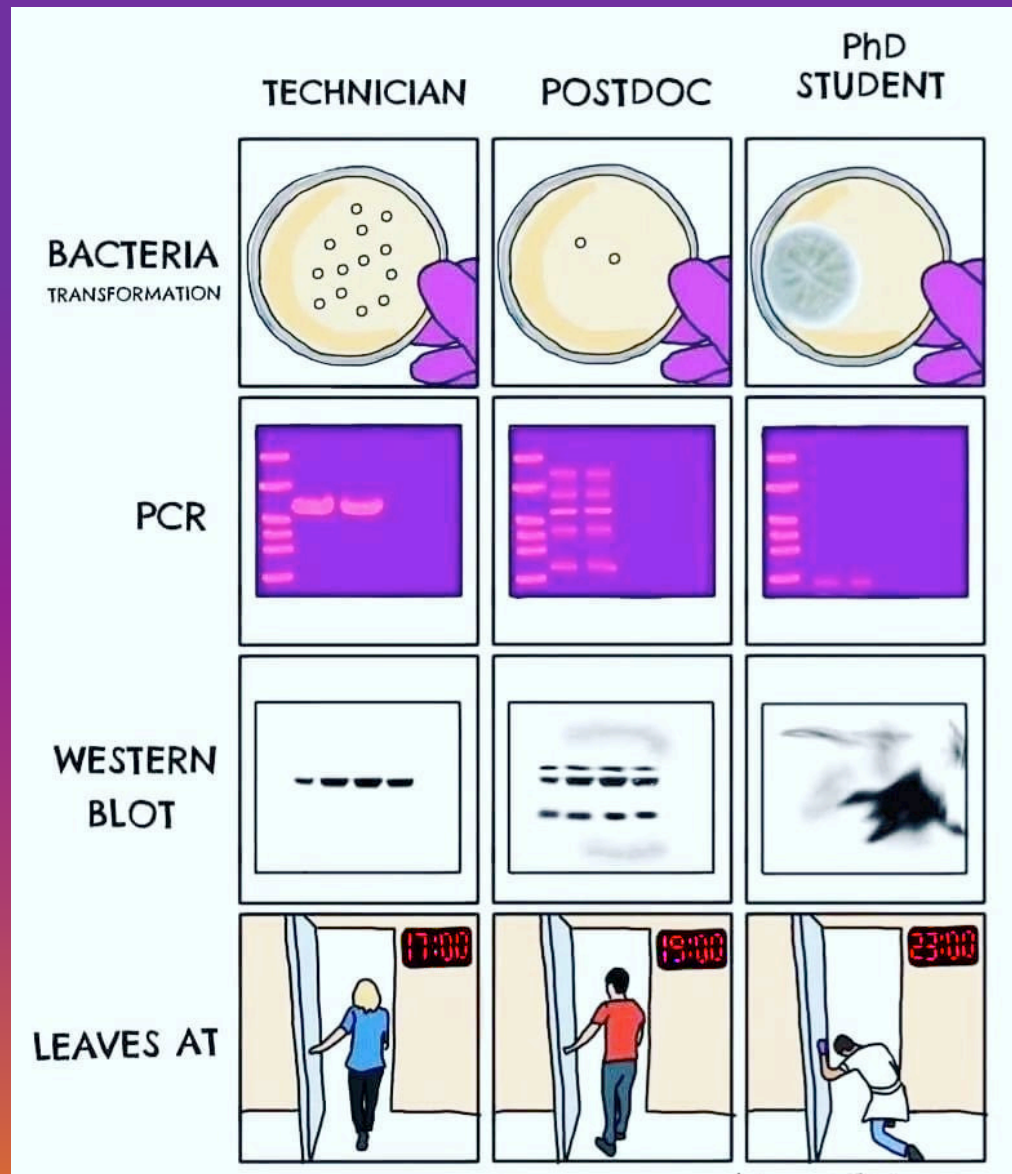
NUANCE BioCryo

eric-roth@northwestern.edu

they, them, theirs

“Do you have a steady hand?”

STEADY-HANDEDNESS
**a skill that can be
acquired and improved**



- 👋 Hand tremor causes
- 👉 Prepare
- ✌️ During Movement
- 👉 When to Back Away
- 👋 On Flow-State
- 🔬 Useful Tools

Hand tremor causes

Stress

Caffeine

Low blood glucose

Low Vitamin B12 /
protein intake

Some medications
(antihistamines)

Smoking/nicotine

Essential Tremors

Alcohol withdrawal

Medical conditions

(Parkinson's, Multiple Sclerosis,
Hyperthyroidism, Brain and
Liver disorders)

👉 Prepare

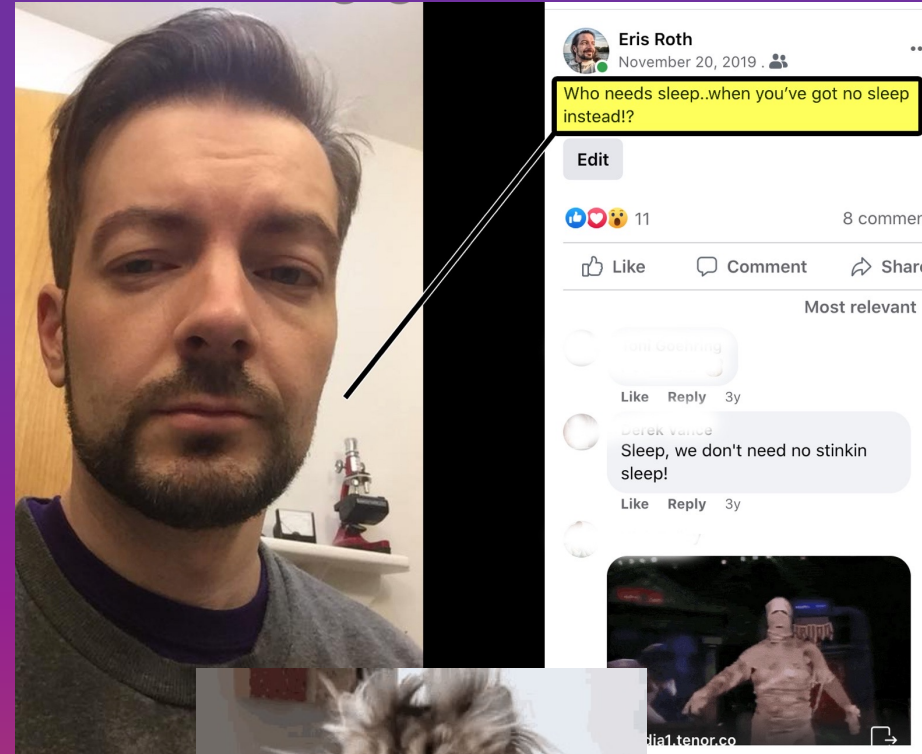
- Rest
- Diet
- Relax muscles
- Calm yourself
- Loosen up / warm up exercises
- Plan ahead
- Equipment layout/ergonomics
- Visualization/practice movement



Prepare: Rest

Sleep deprivation impairs

- Sensorimotor function ¹
(judgement of fine touch, temperature, pressure)
- Near/far vision and ciliary muscle reaction time ²
- Oculomotor impairment (object tracking) ³
- Shorter duration of fine motor control / faster muscle exhaustion ⁴
- Patience, attention, decision making ⁵



👉 Prepare: Diet

- ✓ Avoid stimulants like caffeine, chocolate, and excessive sugar.
- ✓ Low blood sugar results in jittery movements. Never attempt steady-handedness on an empty stomach.
- ✓ Allow 30+ minutes for digestion after a large meal /
- ✓ I personally find (unfortunately) the sweet-spot for steady-handedness occurs approximately 1 hour to 30 minutes before getting hungry.

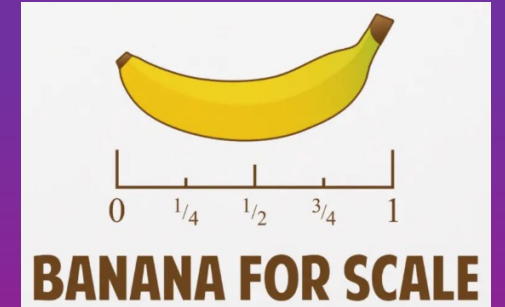
👉 Prepare: Diet

Eat a banana?!

(personal experience, perhaps due to starches, electrolytes, and K?, (avoid overripened bananas, sugar))

Spinach, Salmon

K⁺ ion as an essential vasodilator substance contributing to bloodflow with movement (exercise hyperemia) in humans. ⁶



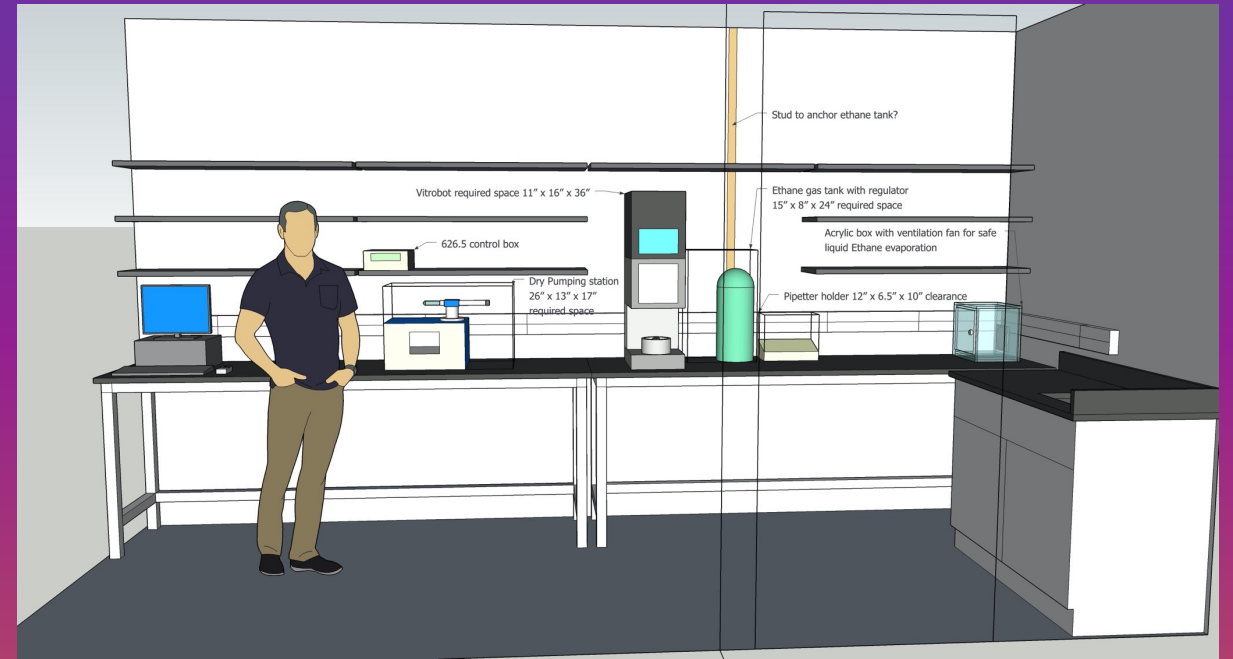
👉 Prepare: Plan ahead

- Thorough experiment design (how many samples/conditions?)
- Consumables and sample setup
- Equipment alignment/
- Careful planning and setup can easily take half of a day.

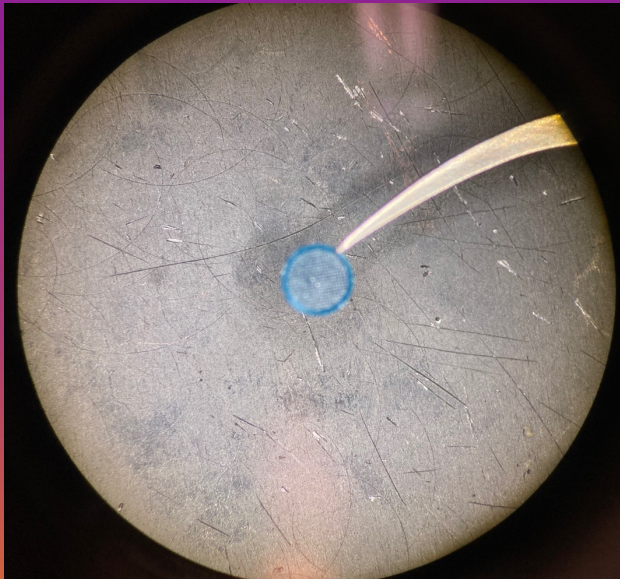
Time flies!

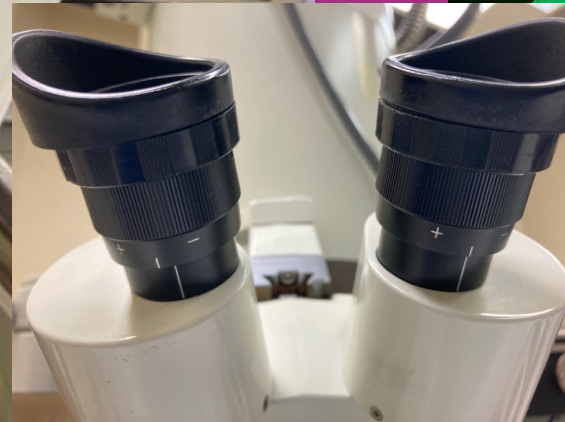
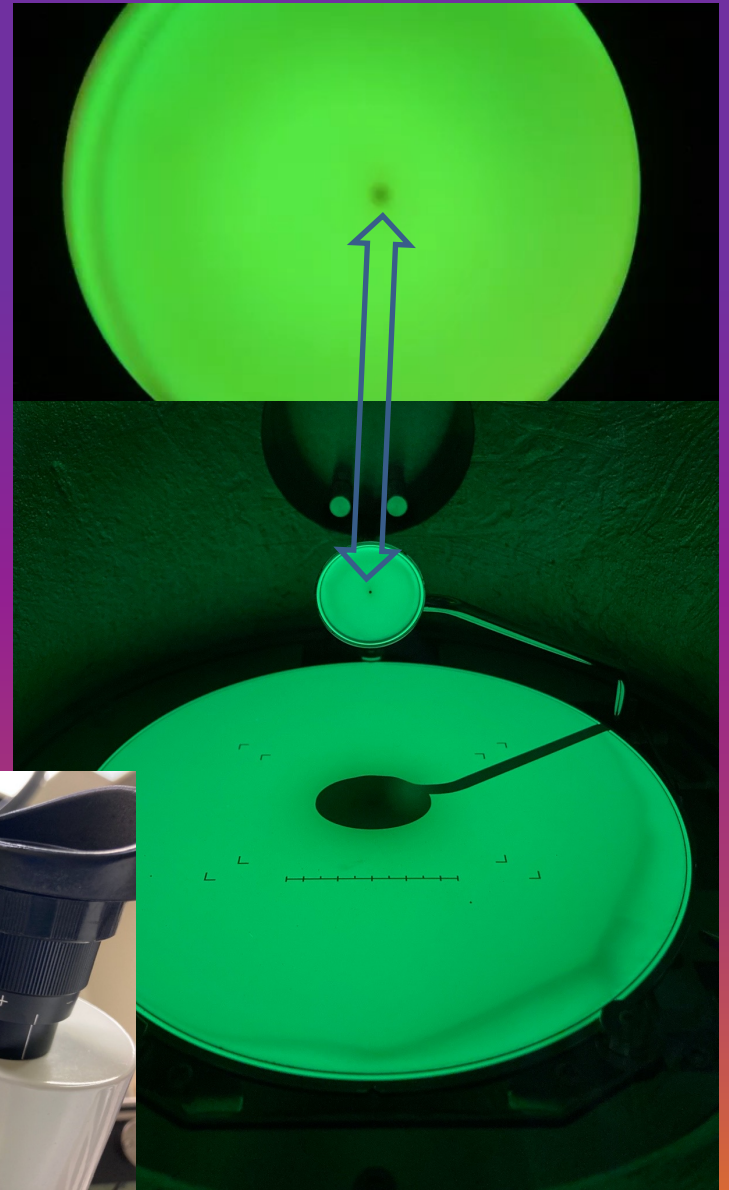
How long do you need to setup?

Will you have enough time for the experiment without rushing?



Aligning oculars on
stereo microscope
and TEM to suit your
vision





It takes less than a minute to make an organized bench to improve workflow



👉 Prepare: Relax muscles

- Avoid heavy lifting / high impact, running, moving heavy boxes, pulling LN or gas tanks, opening stiff valves, hammering, etc. prior to attempting steady-handedness.
- Allow 5 to 30 minutes for muscles to relax if exposed to excessive weight or harsh impact.

👉 Prepare: Calm yourself

Meditation or cognitive feedback relaxation technique method (tapping method)

Warm up hands in sink

Chewing gum (look up reference)

("chewing reduces stress-induced changes in central nervous system morphology, especially in the hippocampus and hypothalamus")⁹

👉 Prepare: Loosen up



👉 Prepare: Loosen up



✌️ During Movement

- Anchoring, anchoring, anchoring!
- Moving with swift confidence
- Breathing technique
- Full-Arm-Movement



During Movement: Anchoring

- A. For steady full arm movement, anchor body in chair if sitting or lean against something if standing
- B. For steady arm/hand movement below elbows, anchor elbows/fore arms +A
- C. For steady hand movement, anchor fore arms, wrists, + A & B
- D. For steady finger movement, anchor ulnar border and thenar eminence if possible, + A, B, & C

👉 During Movement: Anchoring

Minimize pivot points of arms, wrists, hands, fingers, by resting on solid surface

Becomes instinctual

Elbows

Wrists

Ulnar ridge

Pinky knuckle

Fingers





During Movement: Moving with, “swift confidence”

Swift movement comes with experience, Confidence comes with success



Prepare:
Visualization

FOR CRITICAL MOVEMENTS

Don't start movement without first visualizing every specific part

- What are you holding onto and when are you letting it go, etc.?
- Is there anything in the way (ergonomics/layout)?

It's like writing a computer command and clicking execute, or choreographing a dance

Hesitation is the enemy of steady movement

Practice the movement if necessary/possible

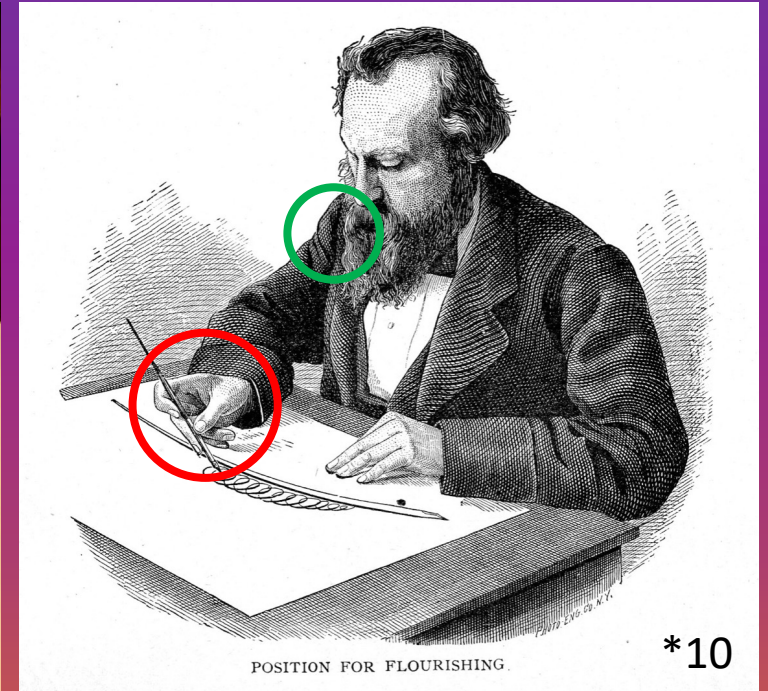
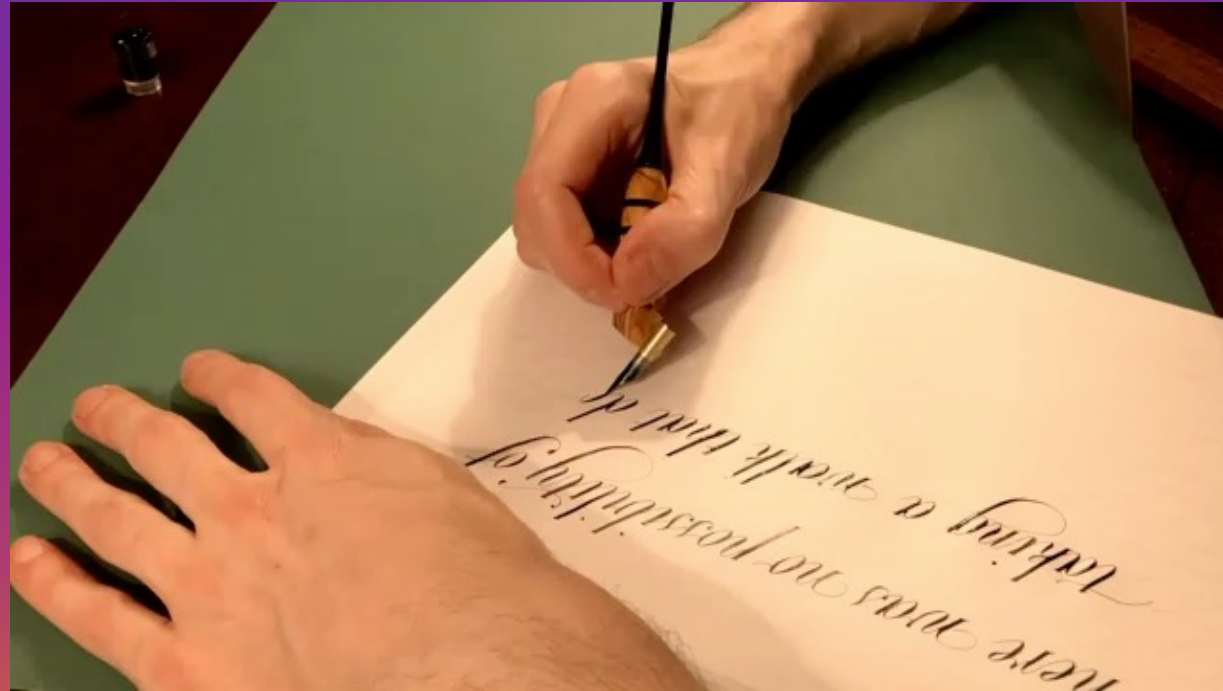
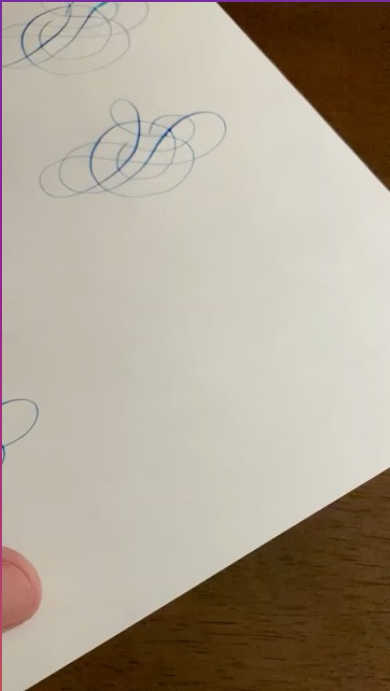
👌 During Movement: Moving with, "swift confidence"



✌️ During Movement: Full arm movement

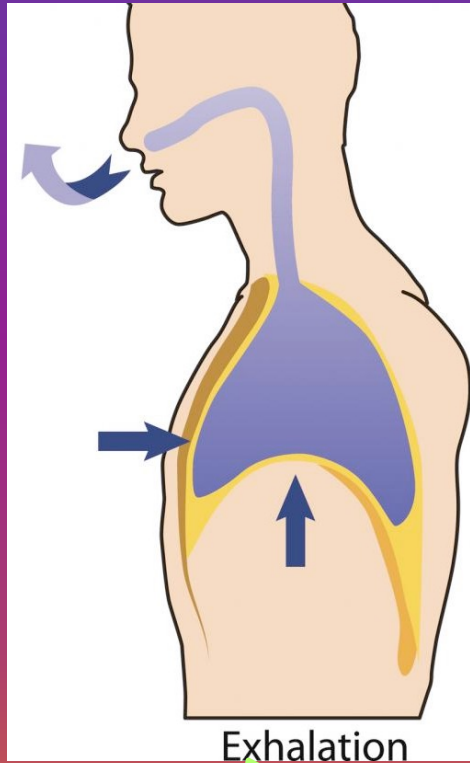
Fingers are imprecise and have a short range of movement

Fingers, hand, and wrist are static, movement comes from shoulder



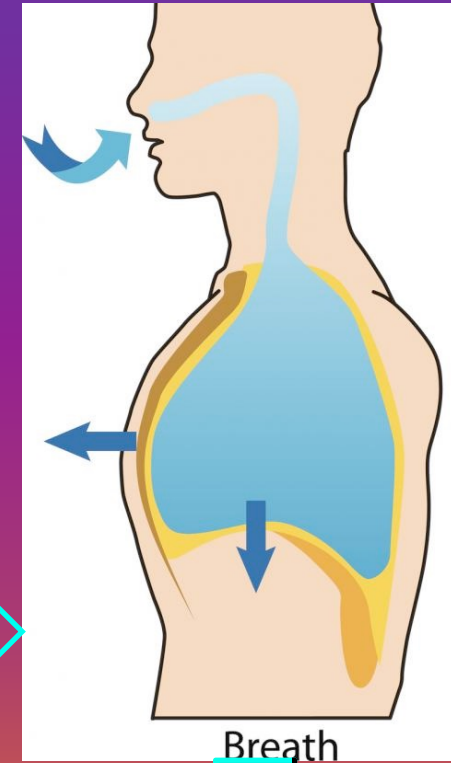
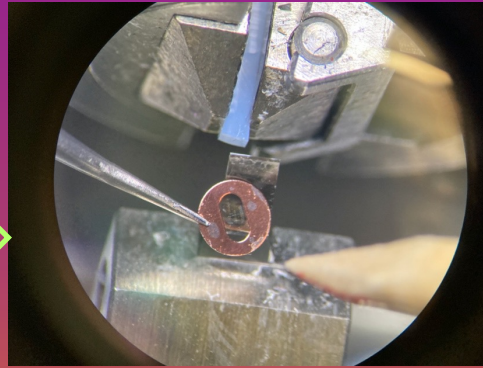
👉 During Movement: Breathing technique

Try this little trick when you need to make a particularly critical/challenging steady movements.



1. Breathe out all air
2. Focus on critical movement
3. Hold breath until finished with task

If needing to breathe in before completion, back away, and try again



👉 When to Back Away

Be aware of yourself and when you shouldn't be attempting steady movements and/or when you need to quit. Work smarter, not harder.

- Hesitation
- Impatience
- Unforeseen problem (something breaks, new condition)
- Running out of time
- Hit level of mental exhaustion

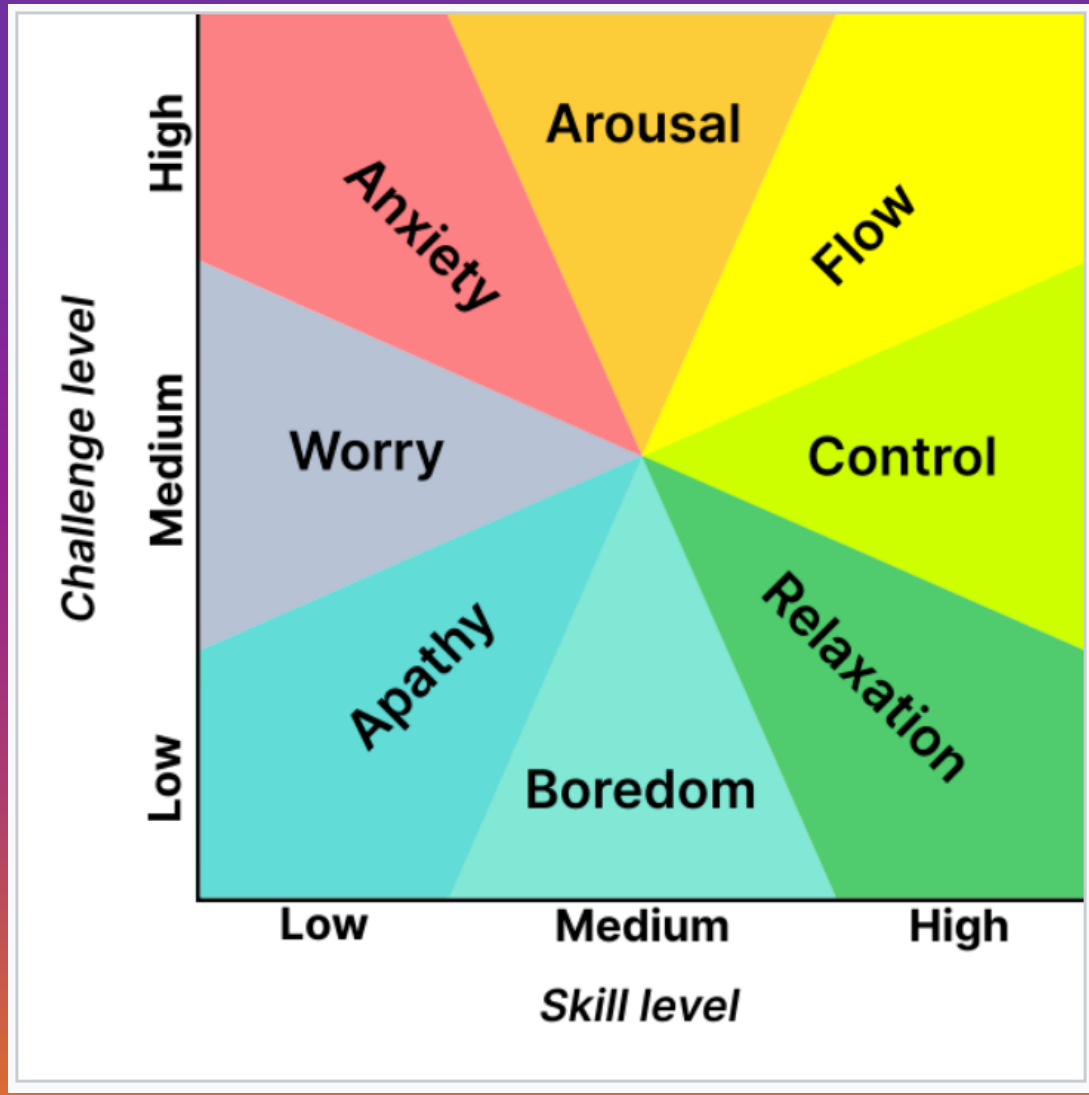
Failure? Sleep on it.

👋 On Flow-State

- Term in Positive Psychology
- “In the zone” A rewarding experience, integrated action instead of set of actions
- Flow, feeling of floating with process, a state of effortless attention, loss of self-consciousness
- In the moment, merging of action and awareness
- Accompanied by time-distortion, encompassing all attention, ignoring outside demands
- Did you forget to eat or annoyed that you need to take a break to eat? You’re probably in Flow State.

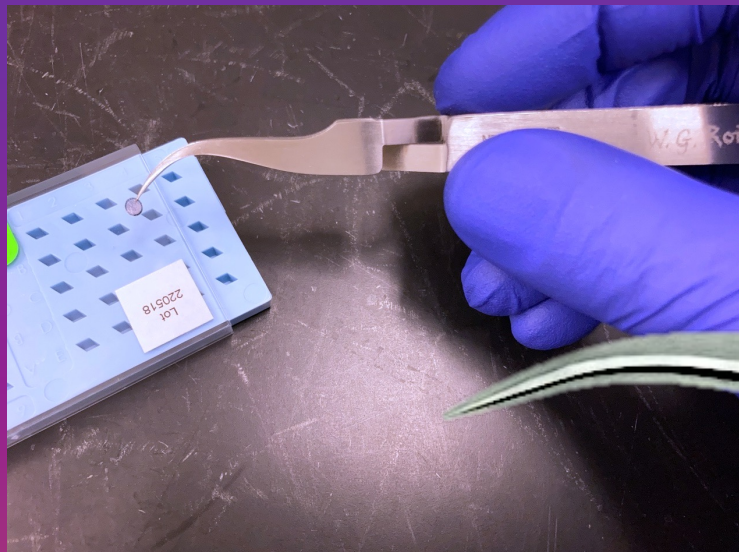
👉 On Flow-State

Skill and challenge levels should be in equilibrium



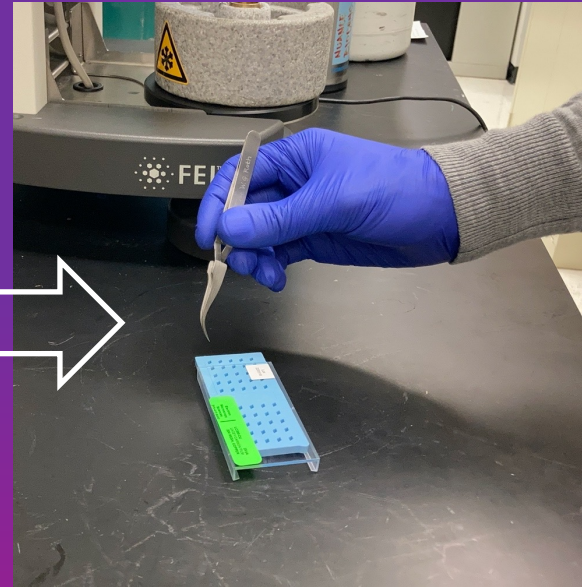


Useful Tools: Optimal grid handling tweezers and grips



Cat #	Description	A	B	C	D	Pack	Price
72864-D	Dumont Style N7 Dumoxel	0.03	0.07	Biological	Polished	Each	\$51.00

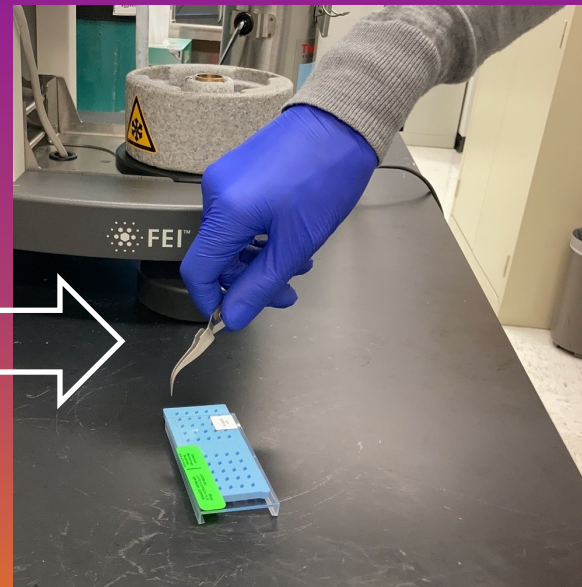
Utensil grip

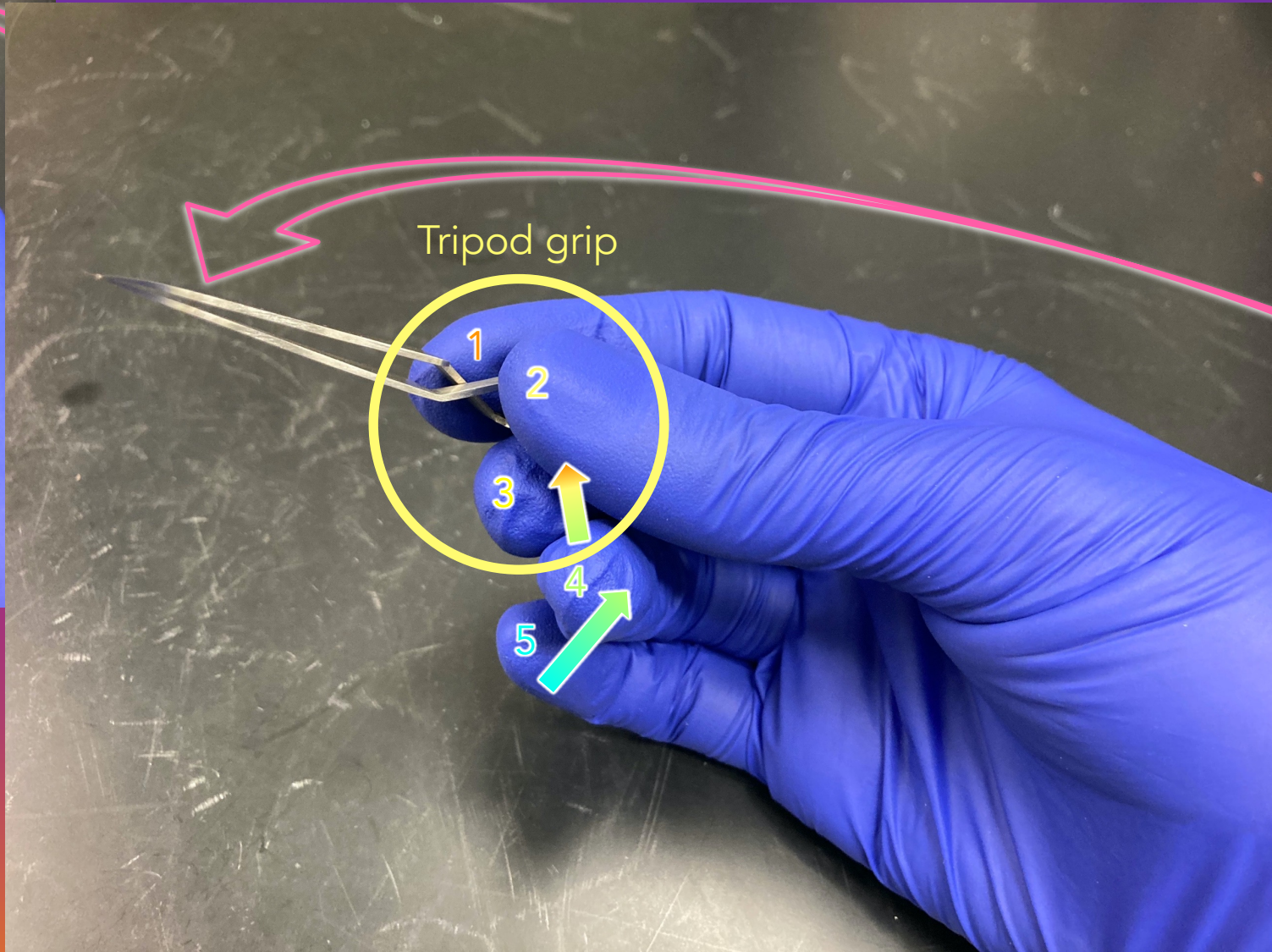
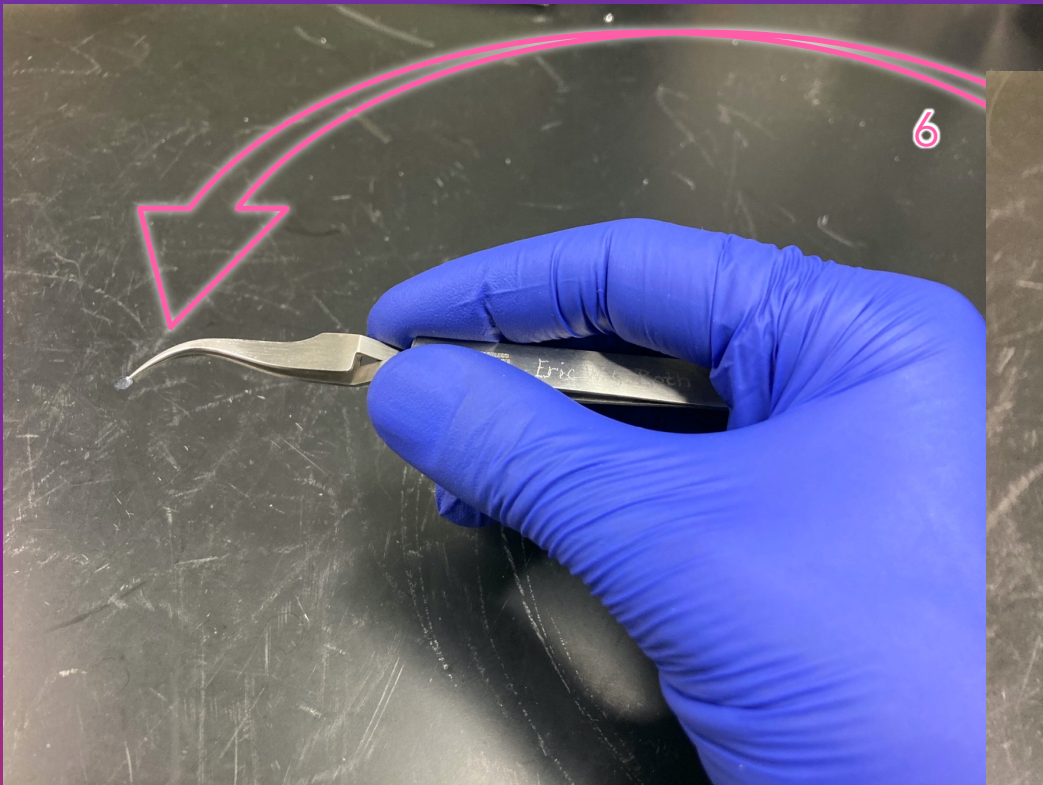


Floating hand produces chaotic movement resulting in greater likelihood of damaged grids

Improper tweezer grips result in less anchoring possibilities and control

Baton grip





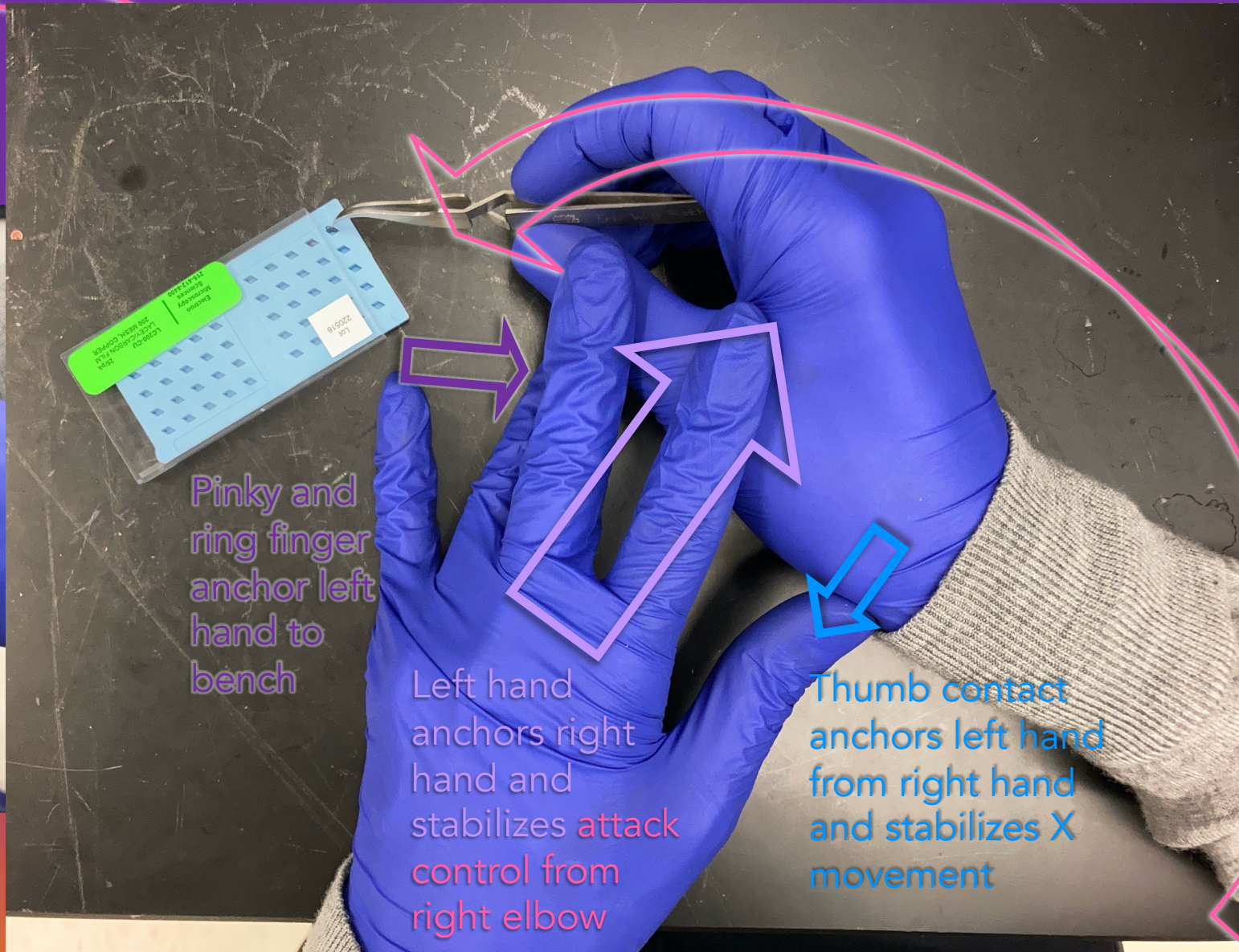
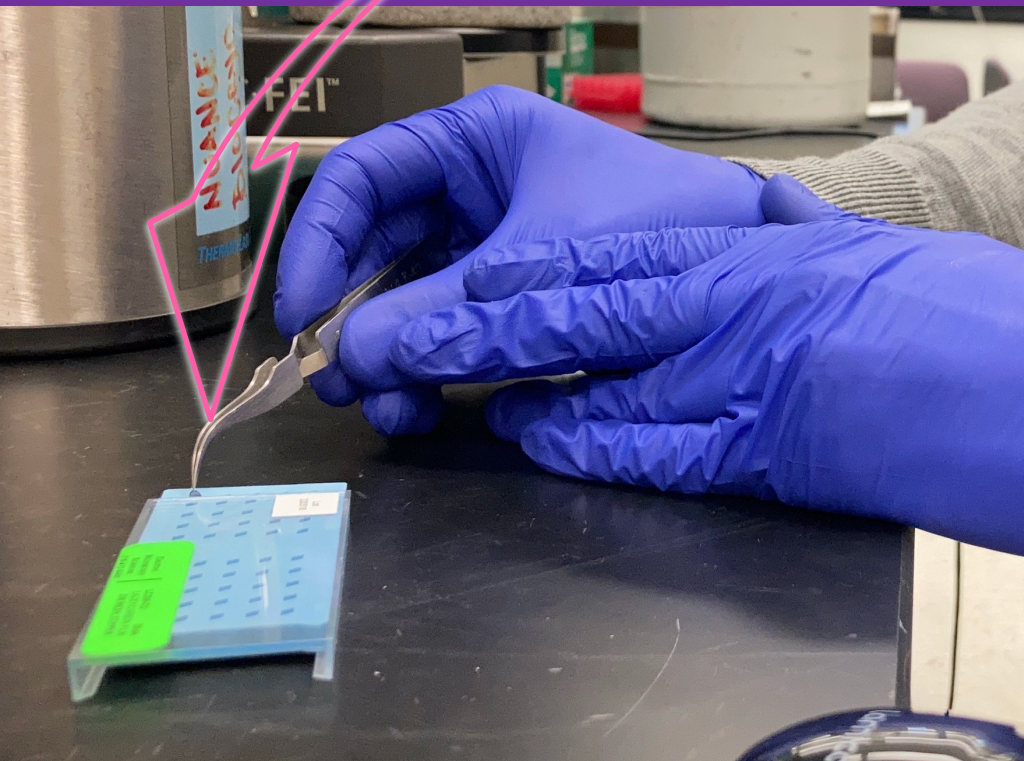
1 Dorsal contact

2&3 Ventral contacts (open and close)

4&5 Anchoring support (4 supports 2&3,
5 supports 4)

6 Dorsal Z attack control (from elbow)

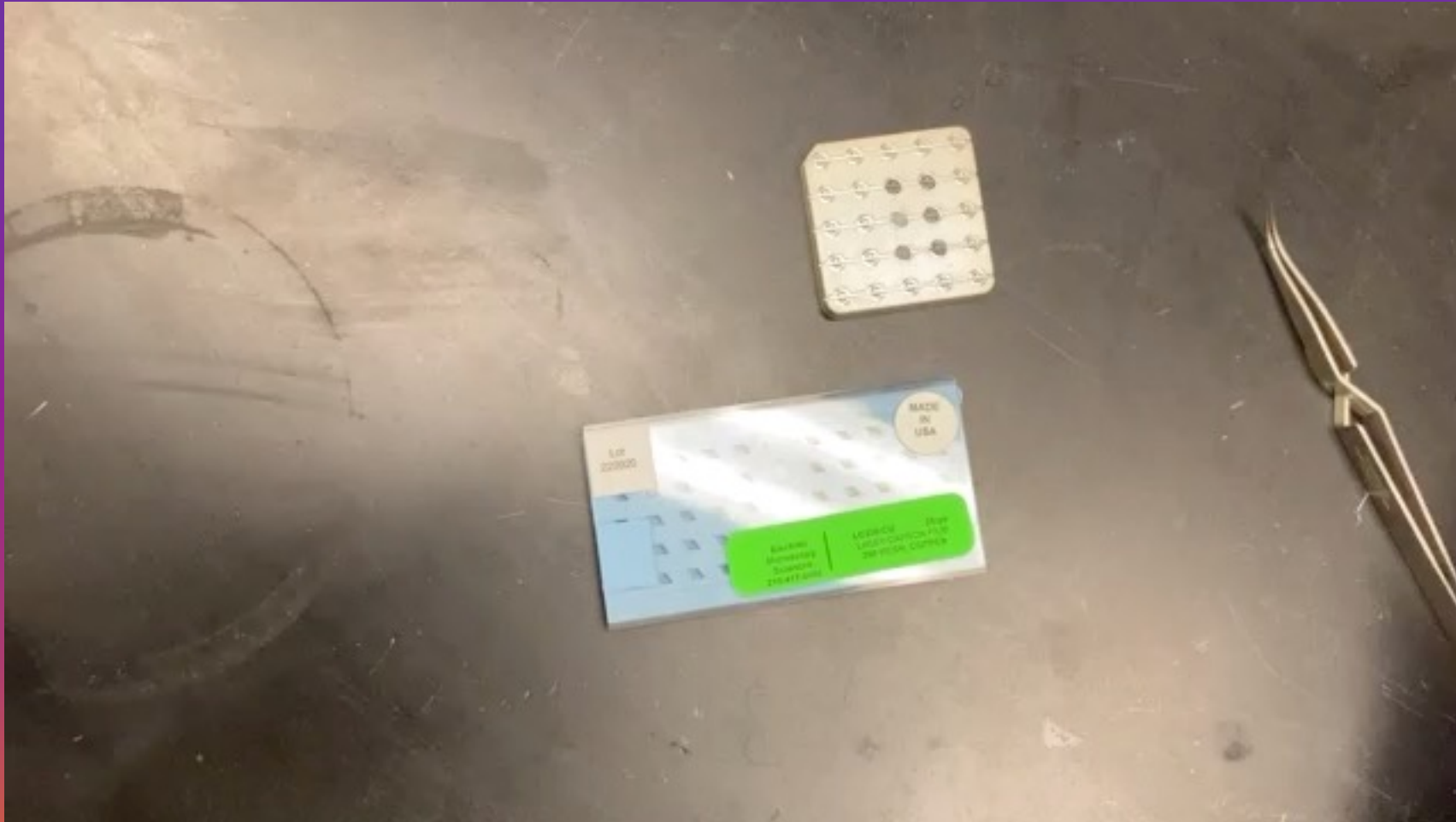
*Fingers are static (2&3, squeeze to
open/close only)



Pinky and ring finger anchor left hand to bench

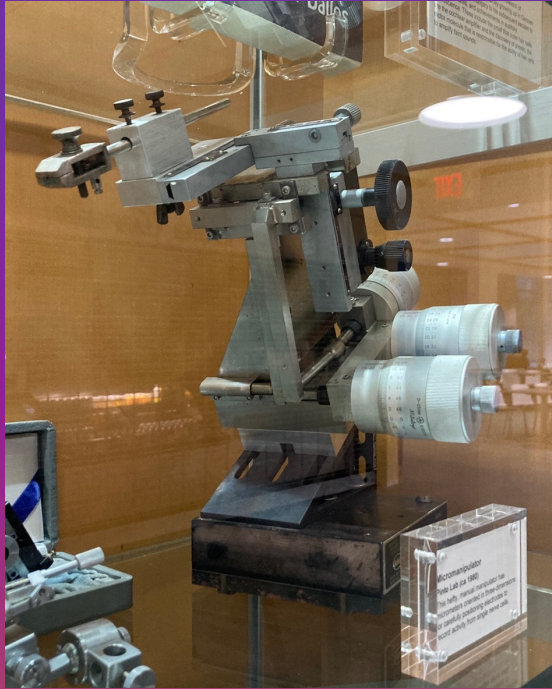
Left hand anchors right hand and stabilizes attack control from right elbow

Thumb contact anchors left hand from right hand and stabilizes X movement



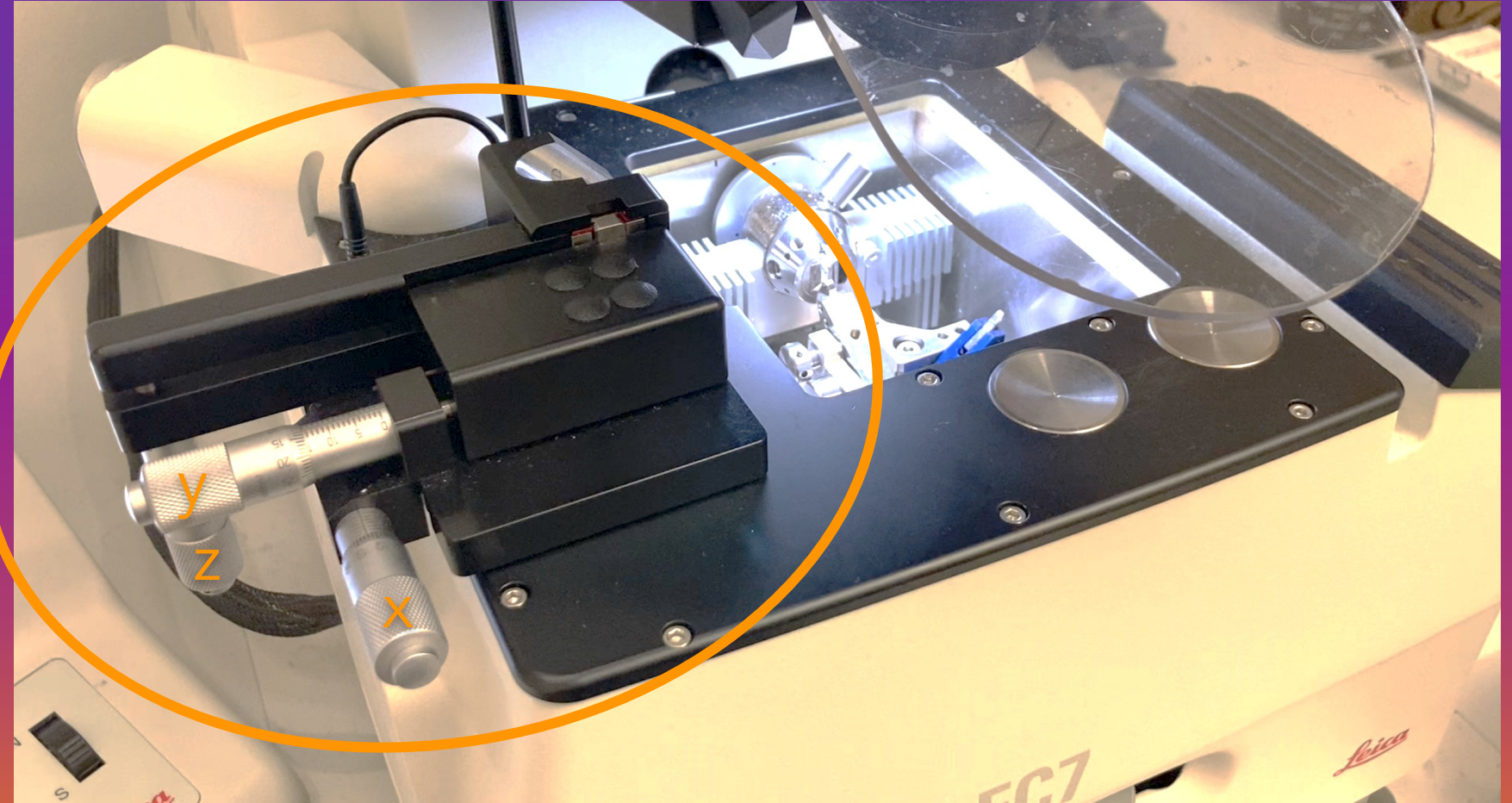


Useful Tools: Micro manipulator



Micromanipulator
Pinto Lab (ca 1980)

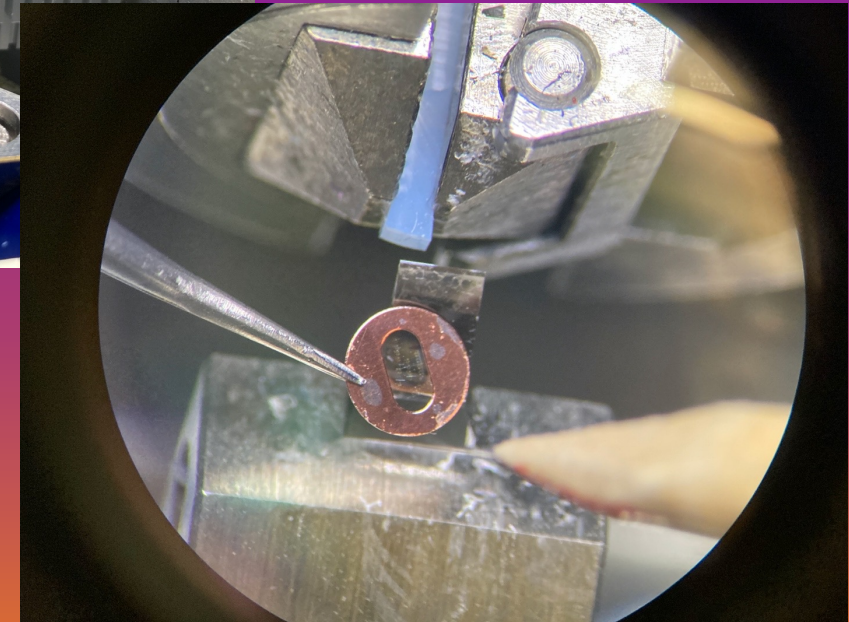
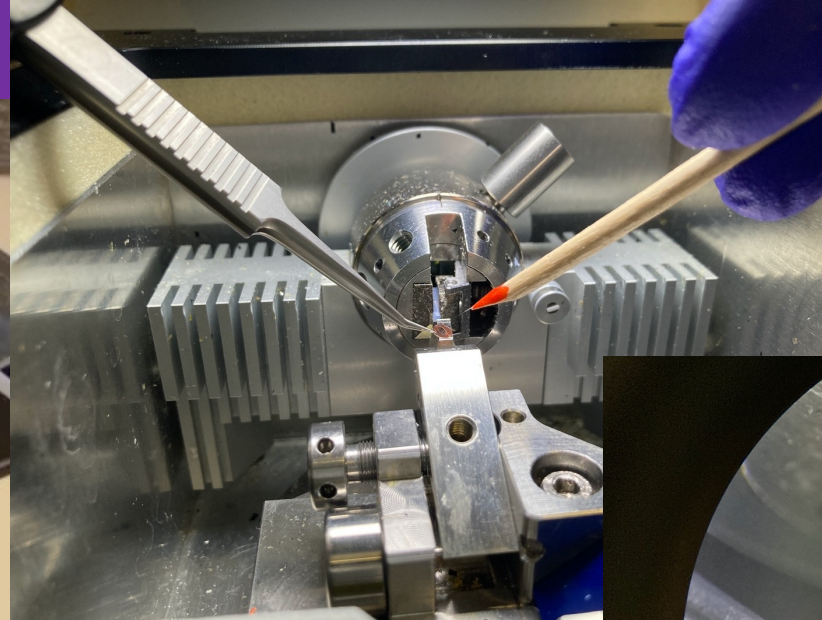
This hefty, manual manipulator has micrometers oriented in three-dimensions for carefully positioning electrodes to record activity from single nerve cells.



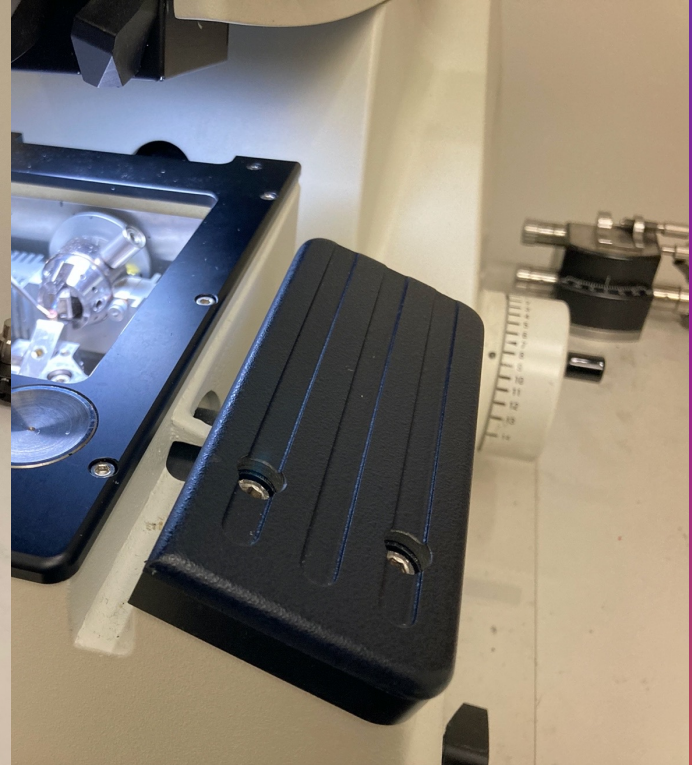


Useful Tools: Micro manipulator

An extra hand for fine x, y, and z control under magnification



Useful Tools: Arm/hand rests



Useful Tools: Maul stick

No anchor points?
Make your own!



References

- 1) Potential Effects of Sleep Deprivation on Sensorimotor Integration during Quiet Stance in Young Adults, *Nielsen et al, 2010*
- 2) Effects of sleep deprivation on cognition, *Killgore 2010*
- 3) Oculomotor impairment after 1 night of total sleep deprivation: a dissociation between measures of speed and accuracy, *De Genero et al, 2000*
- 4) Effects of Total Sleep Deprivation on Fine Motor Performance, *Heon-Jeong Lee et al. 2001*
- 5) Causes and consequences of sleepiness among college students, *Hershner and Chervin 2014*
- 6) Blood glucose and brain function: interactions with CNS cholinergic systems, *Stone et al 1988*
- 7) Elevated extracellular potassium prior to muscle contraction reduces onset and steady-state exercise hyperemia in humans , *Terwood et al 2018*
- 8) [https://en.wikipedia.org/wiki/Flow_\(psychology\)](https://en.wikipedia.org/wiki/Flow_(psychology))
- 9) Mastication as a Stress-Coping Behavior, *Kubo et al 2015*
- 10) Ames guide to self instruction, Practical and artistic penmanship, *Ames, D.T., 1884*

Thank you!

Matthew Cheng (discussions on Flowstate)

Zoha Syed (discussions on steady-handedness)

NUANCE colleagues

NYU colleagues

Contact Info



ERIC W. ROTH

Core Scientist

NUANCE, BioCryo Facility

eric-roth@northwestern.edu