Lab Notebook Submission Summaries

Microscopy and Cell Motility (Lab 2) – Sessions 3 & 4

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PHYS 332

Week 3 Submission: Session 3

Files: `https://github.com/Ahilan-Bucket/phys332W-sfu/tree/main/Lab2-Microscopy-and-Motility`

Session Overview

Date: 10-Feb-2026 **Lab Partner:** Nathan Unhrn **Pages:** 6–26
Recorder: Ahilan Kumaresan
Objective: Observe live cells (yeast, HT1080 stained slides, pond water organisms); pivot from *E. coli* plan after culture became unavailable; recalibrate microscope; collect preliminary data on motile organisms.

Key Files:

- `calibrate0000.tif`, `calibrate0001.tif` — Calibration images
- `yeast-10x.avi`, `yeast-100x.avi`, `yeast-200x.avi` — Yeast dilution videos
- `unknown.tif`, `unknown2.tif` — Unknown pond water organisms
- `ht1080.tif` — HT1080 malignant cells

Key Measurements (Session 3):

Parameter	Value	Notes
Pixel size (100×)	68.4 nm/px	Matches Session 1 (68.45 nm/px)
Unknown Cell 1	∼55–58 µm	Possible spore or air bubble
Unknown Cell 2	∼14 × 19 µm	Possibly *Pandorina*

Week 4 Submission: Session 4

Session Overview

Date: 12-Feb-2026 **Lab Partner:** Nathan Unhrn **Pages:** 52–81
Recorder: Ahilan Kumaresan
Objective: Verify calibration; check incubated pond water for motile organisms; explore onion cell cytoplasmic streaming as candidate short project; select project for Sessions 5–6.

Key Files:

- `calibration-100x-feb-12.tif` — Calibration image
- `onion-stream-01.avi` — Onion streaming video (120 frames)

- `onion2-stream.avi` — Onion streaming video (240 frames, nucleus visible)
- `onion-stained-10x.tif`, `onion-stained-50x.tif` — Crystal Violet stained onion
- `unknown-3.avi`, `unknown4.avi` — New pond water organisms
- `onion2-trackresults.txt` — Tracking data export

Key Measurements (Session 4):

Parameter	**Value**	**Notes**
Pixel size (100×)	68.7 nm/px	Confirmed (condenser shift ∼0.4%)
Mean streaming speed	0.0228 ± 0.0071 µm/s	Automated tracking (top 20)
MSD exponent α	1.662 ± 0.052	Superdiffusive
D_{eff} (onion)	0.000623 ± 0.000038 µm^2/s	Effective diffusion
Directionality ratio	0.540 ± 0.229	Mixed directed + random
Corrected D (1 µm beads)	0.507 µm^2/s	Within ∼15% of theory (0.441)

Executive Summary

Key Figures

Key Tables

Conclusions

Calibration (p. 58):

Session 2 used 0.345 µm/px (INCORRECT). Correct: 0.0684 µm/px, confirmed in Sessions 1, 3, and 4.

This resolves the 20–40× discrepancy in Week 1 D values.
Corrected 1 µm bead D within ∼15% of theory.

Onion Cell Streaming (p. 71):

MSD exponent $\alpha = 1.662 \pm 0.052 \rightarrow$ **superdiffusive**.

Between pure diffusion ($\alpha = 1$) and ballistic ($\alpha = 2$).
Consistent with directed cytoplasmic streaming along actin filaments + random thermal fluctuations.

Project Selection (p. 75):

Bead Diffusion selected for Sessions 5–6.

Best systematic comparison to Stokes–Einstein theory
with varied viscosity (glycerol) and bead size (1, 5 µm).

Summary

Sessions 3–4 transitioned from passive observations (beads, fixed cells) to exploring active biological transport. The key discovery was **onion cell cytoplasmic streaming** with MSD exponent $\alpha = 1.66 \pm 0.05$, clearly distinguishing directed intracellular transport from Brownian diffusion. The calibration error from Session 2 (5× overestimate) was definitively resolved by consistent measurements across Sessions 1, 3, and 4 (all within 68.4–68.7 nm/px).

Not completed: *E. coli* imaging (culture unavailable), bead diffusion verification (deferred to Sessions 5–6).

Selected project for Sessions 5–6: Bead Diffusion (varied viscosities and sizes) + yeast cell population study.