
Education

- PhD, Genetics & Biological Education** Aug 2015 – May 2019
University of Northern Colorado (Greeley, Colorado)
“A multifaceted approach to investigate genetic aspects in *Cannabis sativa*”
Graduate Dean’s Citation for Excellence
Graduate Dean’s Citation for Outstanding Dissertation
- Master of Science, Population Genetics** Aug 2010 – Dec 2012
University of Northern Colorado (Greeley, Colorado)
“Population genetics determining hybridization levels and directionality of gene flow between *Sclerocactus glaucus* and *S. parviflorus* using nuclear and chloroplast DNA analysis.”
- Bachelor of Science, Cellular and Molecular Biology** Aug 2007 – Dec 2009
University of Northern Colorado (Greeley, Colorado)
- Animal Anatomy and Physiology** Aug 1992 - May 1997
Colorado State University (Ft. Collins, Colorado)

Publications

- Schwabe, A.L.**, Johnson, V., Harrelson, J. and McGlaughlin, M.E., 2023. Uncomfortably high: Testing reveals inflated THC potency on retail Cannabis labels. *PLoS one*, 18(4), p.e0282396.
- Schwabe, A.L.**, Naibauer, S.K., McGlaughlin, M.E. and Gilbert, A.N., 2022. Human olfactory discrimination of genetic variation within Cannabis strains. *Frontiers in Psychology*, p.6818.
- Schwabe, A.L.**, Hansen, C.J., Hyslop, R.M. and McGlaughlin, M.E., 2021. Comparative genetic structure of Cannabis sativa including federally produced, wild collected, and cultivated samples. *Frontiers in Plant Science*, p.2098.
- Vergara, D., Huscher, E.L., Keepers, K.G., Pisupati, R., **Schwabe, A.L.**, McGlaughlin, M.E. and Kane, N.C., 2021. Genomic evidence that governmentally produced Cannabis sativa poorly represents genetic variation available in state markets. *Frontiers in plant science*, 12, p.668315.
- Schwabe, A.L.** and McGlaughlin, M.E., 2019. Genetic tools weed out misconceptions of strain reliability in Cannabis sativa: implications for a budding industry. *Journal of Cannabis Research*, 1(1), pp.1-16.
- Schwabe, A.L.**, 2019. *A multifaceted approach to address variation in Cannabis sativa*. University of Northern Colorado.
- Rudolph, H.A., **Schwabe, A.L.** and Soleimanibarzi, N., 2018. " How Do You Know if They Help?" Implementing Multiple Student-Centered Learning Opportunities in Human Anatomy and Physiology Undergraduate Labs. *HAPS Educator*, 22(3), pp.253-261.
- Rudolph, H.A., **Schwabe, A.L.** and Johnson, V., 2018. " It Started Because of a Snow Day!" Making Online Videos as Customized Learning Tools. *HAPS Educator*, 22(1), pp.69-72.

- Rudolph, H.A. and Schwabe, A.L., 2017. " Yes! Use Your Cell Phones!" Active Learning with Technology in an Anatomy and Physiology Lab. *HAPS Educator*, 21(3), pp.75-79.
- Schwabe, A.L., Neale, J.R. and McGlaughlin, M.E., 2015. Examining the genetic integrity of a rare endemic Colorado cactus (*Sclerocactus glaucus*) in the face of hybridization threats from a close and widespread congener (*Sclerocactus parviflorus*). *Conservation Genetics*, 16, pp.443-457.
- Schwabe, A.L., Hubbard, A.R., Neale, J.R. and McGlaughlin, M.E., 2013. Microsatellite loci development for rare Colorado *Sclerocactus* (Cactaceae). *Conservation Genetics Resources*, 5, pp.69-72.
- Schwabe, A.L., 2012. Analysis of microsatellites from *Sclerocactus glaucus* and *Sclerocactus parviflorus* to assess hybridization levels and genetic diversity.

Presentations

- The Future of Cannabis Research.** Panel discussion with Jeremy Klettke (moderator), Jahaan Marcu PhD, and Steven Philpott Jr. MJ Unpacked, Atlantic City, New Jersey (upcoming April 2024).
- Defining Quality in Cannabis: A multidisciplinary Exploration.** Panel discussion with Jeff Rawson (moderator), Jesse Pitts, and Samantha Seagaard. MJ Unpacked, Atlantic City, New Jersey (upcoming April 2024).
- Utilizing Basic Genetic Tools to Uncover Genotype-Phenotype Complexity in Cannabis.** Cannabis Genomics Conference, Barcelona, Spain (March 2024).
- Genetic vs. Aroma Consistency in Cannabis.** CANN International Cannabis Chemistry Journal Club Live Webinar (March 2024).
- Whiffs of Wisdom: Decoding Cannabis Aromatic Variation.** Cannabis Public School, online live webinar (March 2024).
- Higher Than Expected: Reported THC% on Retail Flower vs. Observed is Inflated.** (poster) Emerald Conference, San Diego CA. (March 2023)
- Genetics Presentation** and discussion panel with Dr. Eleanor Kuntz (Leafworks), Todd McCormick (Authentic Genetics), Mojave Richmond (Breeders Best), and George Workman (Kyagene), CaliSensi Cannabis 360 Conference. Cannabis Growers' Cultivation Conference, Aptos CA. (December 2022)
- Cannabis Education: Higher Learning for Cultivating Success.** Delta 8 Expo in Partnership with CBD Expo Tour, Orlando, FL. (October 2022)
- Sources of Variation in *Cannabis sativa*.** International Cannabinoid Derived Pharmaceuticals Summit, Boston MA. (September 2021)
- Human Olfactory Discrimination of Genetic Variation in *Cannabis* Strains** (Poster). Association for Chemoreception Sciences Annual Meeting, Bonita Springs, Florida. (April 2019)

- Aroma perception reflects genetic variation within *Cannabis* strains.** Institute of Cannabis Research Conference, Pueblo Colorado. (March 2019)
- Stirring the Pot: Genetic Analysis of Hemp-type, Legal Drug-type, and Federally-Supplied Research Grade *Cannabis*.** Institute of Cannabis Research Conference, Pueblo Colorado. (March 2019)
- A Multifaceted Approach to Address Variation in *Cannabis sativa*.** Doctoral Defense, University of Northern Colorado, Greeley, Colorado. (March 2019)
- Cannabis sativa*: using genetic analyses to stir the pot.** Botany 2018 Conference, Rochester, MN. (July 2018)
- Joint Forces: the relationship between genotype and chemotype in *Cannabis*.** University of Northern Colorado, Research Day. (April 2018)
- Genetic Analysis of *Cannabis*: Hemp, Retail and NIDA Strains** (Poster). University of Northern Colorado, Research Day, Greeley, Colorado. (April 2018)
- Cannabis* genetics: Strain inconsistency in a budding industry.** Cannabis Research Interest Group, University of Northern Colorado, Greeley, Colorado. (January 2018)
- Cannabis sativa*: What genetics tell us about the “devil’s lettuce”.** Café Botanique, Denver Botanic Gardens, Denver, Colorado. (January 2018)
- Names, strains, and claims, oh my! Incorporating the use of genetic analysis in a budding industry.** Society of In Vitro Biology Conference, Workshop on Cannabis Best Practices and Regulations, Raleigh Convention Center, Raleigh, North Carolina. (June 2017)
- Genetic tools weed out misconceptions of strain reliability in *Cannabis sativa*: implications for a budding industry.** Institute of Cannabis Research Conference, Pueblo, Colorado. (April 2017)

Relevant Experience

Director of Research, Development & Education Shore Organics/420 Organics (Tom’s River, New Jersey)	April 2021- June 2024
Board Member Agricultural Genomics Foundation (Louisville, Colorado)	July 2022- present
Associate Lecture Professor University of Colorado, (Boulder, Colorado) <i>Modern Cannabis Science</i> <i>Basic Cannabis Science</i> <i>Advanced Cannabis Science</i>	May 2020 - present
Affiliate Faculty University of Northern Colorado (Greeley, Colorado)	March 2020 - present

Adjunct Faculty University of Northern Colorado (Greeley, Colorado)	August 2020-December 2021
Research Coordinator Mile High Labs (Broomfield, Colorado)	July 2019 - Jan 2020
Course Development Agricultural Genomics Foundation (Louisville, Colorado)	July 2019- present
Advanced Anatomy & Physiology Lecturer University of Northern Colorado (Greeley, Colorado)	June - July 2018
Conservation Biology Course Lecturer University of Northern Colorado (Greeley, Colorado)	Jan-May 2018
Laboratory coordinator, instructor, and manual author Human Anatomy & Physiology University of Northern Colorado (Greeley, Colorado)	May 2015 -June 2019
Genetics Lab Manager Denver Botanic Gardens Conservation Research Dept (Denver, Colorado)	Dec 2012- Jan 2015
Herbarium Coordinator University of Northern Colorado (Greeley, Colorado)	2009-2012

Project Experience

420 Organics/ Shore Organics

- Spearheaded data collection and seed selection to ensure successful cultivation.
- Assessed and assisted with Integrated Pest Management program.
- Collaborated with Universities to introduce Cannabis Education Curricula for students interested in entering the Cannabis industry post-graduation.
- Developed and conducted internship programs for Stockton University
 - Science: covers aquaponic farming and *Cannabis* science including compliance and testing.
 - Policy: covers aquaponic farming, plant basics, compliance, regulatory agencies, and current rules.
- Designed internship programs for Rutgers University
 - Science: covers aquaponic farming and *Cannabis* science including compliance and testing.
 - Policy: covers aquaponic farming, plant basics, compliance, regulatory agencies, and current rules.
- Compiled and composed Standard Operating Procedures (SOPs) to ensure Shore Organics is following Good Agricultural Practices.

- Compiled and composed a Pest, Pathogens and Problems Manual to assist employees in identifying issues within the cultivation facility
- Compiled and composed Standard Operating Procedures (SOPs) tailored for New Jersey Cannabis Regulatory Commission Rules and specifications for Cannabis business license awardees.
- Monitored and tested plants to ensure compliance under the New Jersey Department of Agriculture Hemp regulations.
- Designed and coordinated education and training programs for Cannabis Industry professionals.
- Designed marketing and promotional materials for the products and education programs.
- Cannabis Courses Developed
- Plant basics, Anatomy & Physiology, Seed to Fruit, History, Taxonomy, Species, Science & Public Perspectives, Bridging the Science Gap, Genotype, Phenotype, Chemotype, Mutations, Pests and Pathogens, Phytochemicals Part 1, Phytochemicals Part 2, Testing Protocols, Testing Methods, Variation & Quality, Strains, Cultivars & Varieties, Categories & Communication, Strain Names. NIDA & Medical Grade Marijuana, Strain Information & Databases, Cultivation, Genetics & Breeding, Intellectual Property, Processing and Manufacturing, Packaging, Labeling, and Advertising, The ECS, Medical Cannabis & Pharmaceuticals, Cannabinoids: Properties & Applications, Minor Cannabinoid Products, Routes of Administration, Public Health Concerns, Personal Health Concerns, International & US Policy, Regulatory Agencies, NJ Specific Rules, Flower Facts for Budtenders, Cannabis Crash Course.

Agricultural Genomics Foundation

- Board Member assisting with promoting and bringing awareness to the cannabis community with our mission to educate, keep genomic and bioinformatic data public, and support and empower small businesses, farmers, legacy growers, and the cannabis community.
- Create marketing and promotional materials.
- *Modern Cannabis Science* course development, a course which has been consistently offered online through Continuing Education at least three times per year at CU Boulder, since Summer 2020 (EBIO 4460-581: Special Topics)
- Developing two new courses for CU Boulder and Corsera: *Basic Cannabis Science* and *Advanced Cannabis Science*.
- Organizing collaborative projects with landrace diversity and germplasm conservation and protection leaders, Zomia Seed Collective.

Mile High Labs

- Coordinated collaborative research efforts with the University of Northern Colorado, Colorado State University, and Arizona State University in the United States and well as the University of Ulster, Queen's College, and Kings College in the United Kingdom.
- Launched several research projects to investigate the safety of cannabinoids (CBD and CBG) including a battery of cell toxicity studies and ADME safety studies to determine NOAELs in rodent models.
- Initiated an investigation examining stereoisomeric differences of synthetic and naturally derived CBD.
- Developed an extensive list of whitepaper topics surrounding Hemp and CBD.
- Drafted a toxicology report and NDIN for the FDA regarding the safety of CBD consumption based on history of use, relevant research in the literature, and studies conducted by GW Pharmaceuticals drug application for Epidiolex.
- Compiled a Novel Foods Application for the EFSA demonstrating the safety of CBD consumption based on history of use, relevant research in the literature, and studies conducted by GW Pharmaceuticals drug application for Epidiolex.
- Composed and submitted an NIH Small Business Innovation Research grant to investigate the safety of CBG consumption as well as topical applications.
- Developed training tools for new employee training and sales development.
- Constructed continuing education courses designed to strengthen knowledge and information about *Cannabis*, including units designed around hemp, hemp products, cannabis research, cannabinoids and the endocannabinoid system, and some regulatory information.

University of Northern Colorado

- Developed 10 variable microsatellite regions to determine relationships in *Cannabis sativa*
- Assessed genetic relationships within varieties and among broad categories (hemp, high CBD, and Sativa/Hybrid/Indica drug-types).
- Assessed the relationship between genetic and chemotypic variation using a human sensory study and evaluation of cannabinoid and terpene levels within varieties.
- Compared reported levels of THC_{MAX} to non-affiliated lab test results ($p < 0.0001$).
- Conducted experiments to determine epigenetic changes due to stress in mother plants, clones, and clones of clones.
- Overhauled the Anatomy and Physiology lab curriculum and pedagogy in order to give students an improved learning environment using technology (cell phones, PowerPoint, YouTube, computers) and hands on learning. Student average class grades improved from 65% to >80% as a direct result of the curriculum I designed and implemented with >3,000 students over ~8 semesters.

Denver Botanic Gardens

Phacelia formosula

- Collected and analyzed ISSR data from 450 individuals using GelComparII from Applied Maths and GeneTools from SynGene to investigate diversity levels and possible regional genetic partitioning.
- Oversaw development of 15 variable microsatellites for three proposed species using Next Generation Sequencing (Ecogenics).
- Worked with Nevada Genomics on Multiplex panel design and analyzed fragment data for 450 individuals.
- Organized and formatted data set for statistical analyses and helped interpret results for both ISSR and microsatellite projects

Corispermum navicula

- Collected and analyzed ISSR data from 480 individuals using GelComparII from Applied Maths and GeneTools from SynGene to investigate diversity levels and possible regional genetic partitioning. Organized and formatted data set for statistical analyses and helped interpret results.
- Oversaw development of 12 variable microsatellites using Next Generation Sequencing (Ecogenics) for three putative species.
- Worked with Nevada Genomics on Multiplex panel design and analyzed fragment data for 570 individuals.
- Organized and formatted data set for statistical analyses and helped interpret results.

Sclerocactus glaucus

- Developed 16 species specific microsatellite primers for *Sclerocactus* spp.
- Collected and analyzed microsatellite data using PEAK SCANNER v1.0 (Applied Biosystems) to investigate taxonomic and morphology questions.
- Combined data from Colorado and Utah *Sclerocactus* spp. (*S. glaucus*, *S. parviflorus*, *S. brevispinus* and *S. wetlandicus*).

Physaria (Lesquerella) congesta/ Physaria obcordata

- Assisted in the microsatellite data analysis to investigate diversity levels and possible regional genetic partitioning.

Stropharia

- Collected data from five DNA regions for a phylogenetic study on the fungal genus to attempt to clarify taxonomic confusion within and between closely related taxa.

Coffea arabica var. *geisha*

- Oversaw in the ISSR data collection and analysis of *Coffea arabica* var. *geisha* from Ethiopia and Panama to determine diversity levels as well as the origin of the Panamanian *C. arabica*.

Eligmocarpus cynometroides

- Oversaw in the ISSR data collection and analysis of an extremely rare Madagascan tree species (18 known wild individuals) to determine diversity in the remaining wild populations and the diversity and origin of the *ex-situ* greenhouse propagates.

Laboratory Experience

- Developed R&D techniques to develop organic fish food alternatives for aquaponic systems.
- Used near infrared technology and instrumentation to determine cannabinoid levels in floral tissue.
- Developed data collection methods and protocols to ensure cultivation environments were optimal and identify issues in the facility as they arose.
- Propagated *Cannabis* seeds and clones to assess epigenetic changes due to stress response and resulting physiological expression.
- Developed *Cannabis* extraction methods and protocols for HPCL and GC analysis.
- Designed primers to determine relationships in *Cannabis* using the “Purple Kush” genome and MSATcommander software.
- Utilized population genetic tools to researching and investigating genetic questions of more than 15 species in multiple concurrent projects (Since 2009).
- Extracted and managed DNA samples as well as tissue samples from >2000 individuals. Modified DNA extraction protocols to successfully extract DNA from difficult organisms (Cactus- 96% success rate with modified Qiagen protocol).
- Developed microsatellite libraries for *Sclerocactus* including cloning, DNA sequencing, and primer design as well as NGS library development, primer design and tagged microsatellite multiplex panel design.
- Designed and conducted plate-based microsatellite PCR, primer optimization and PCR amplification of microsatellites.
- Amplified chloroplast and ribosomal DNA regions by optimizing primers and conducted PCR amplification to screen regions and assess variability and evolutionary relationships between closely related species.
- Prepared and ran agarose gels for electrophoresis of DNA and PCR products as well as interpreted, imaged and processed gels for data collection.
- Prepared microsatellite and DNA sequence samples for analyses on a DNA sequencing/genetic analyzer platform.
- Utilized software for data collection and analysis including Peak Scanner, GelCompar II, GeneTools, STRUCTURE, Structure Harvester, GenAlEx, GENEPOP, PopGene, Arlequin, FigTree, Mr. Bayes, Geneious, PAST, Geneland, R and ArcGIS.

- Organized multiple project data and conducted some analyses using Microsoft Excel.
- Proficient in Microsoft Office including Excel for tracking and analyzing large data sets, Word for writing protocols and reports, and PowerPoint and Prezi for creating presentations.

Awards and Grants

Stockton University (2023) awarded to Shore Organics for hemp plastic R&D \$250,000

University of Northern Colorado

- 2019 Graduate Dean's Citation for Excellence
- 2019 Graduate Dean's Citation for Outstanding Dissertation
- 2019 Graduate Student Association. Research/Conference Grant \$600
- 2019 Graduate Student Association. Research/Conference Grant \$600
- 2018 Graduate Student Association. Research/Conference Grant \$150
- 2018 School of Biological Sciences. Research/Conference Grant \$500
- 2018 Graduate Student Association. Research/Conference Grant \$300
- 2017 Graduate Student Association. Research/Conference Grant \$600
- 2016 Gerald Schmidt Memorial Biology Scholarship Award \$375
- 2016 Graduate School. Hutchinson-Lahman Travel Award \$400
- 2015 Graduate Student Association. Research/Conference Grant \$348
- 2012 Graduate Student Association. Research/Conference Grant \$208

Society for In Vitro Biology (2017) Workshop on Cannabis Best Practices and Regulations
Conference invitation and travel award \$1000

Desert Ecosystem Analysis & Restoration (2014) Genetic diversity of *Sclerocactus glaucus*. \$6,839

Colorado Native Plant Society (2011) Myrna P. Steinkamp Grant \$1000

Professional Memberships and Boards

- MJUnpacked Science Committee Member
- GrowDoc Cannabis Consultant
- Emerald Conference Science Committee Member
- Agricultural Genomics Foundation Board Member
- Curious About Cannabis Master Class Educator
- Bace Health, Clinical Validation Team
- National Scholars Honor Society
- Rocky Mountain Society of Botanical Artists

- American Society of Botanical Artists
- Colorado Native Plant Society
- Botanical Society of America

Web links

[Personal website](#)

[Dissertation](#)

[Dissertation Defense](#)

[LinkedIn](#)

[Research Gate](#)

Research Podcasts

[The Fine Print](#), with Caleb Teske

[Future Cannabis Project](#), Uncomfortably High: Testing Reveals Inflated THC Potency on Retail Cannabis Labels, with Damon Giesbrecht.

[The Cannabis Review Show](#), Cannabis Biology.

[MITA](#), Emerald Conference, 2023, Why pheno hunting is important in the process of growing cannabis?

[High on Home Grown](#) Anna Schwabe, AKA Dr Annabis, PHD and Expert in Cannabis Genetics and Biology.

[Growing With Fishes](#). Episode 324 PotentPonics.

[Smoke 'n' Science](#) with Dr. Miyabe Sheilds and Dr. Riley Kirk.

[The Dank Hour](#) with London Niro, Future Cannabis Project, Ron Herrington, Dr. Mark Scialdone, Dr. Tess Eidem, Jonny Dank Tek, Eviane Ita, Che LeBlane and special guests weekly.

[CannaBook Club](#) a weekly Cannabis Research Literature discussion.

[GrowBro Mythbusters](#), with Andrea Meharg of Reveal Cannabis.

[Do Strain Names Matter](#) with Andrea Meharg of Reveal Cannabis.

[JotaHerb's Grow and Tell](#): Indica and Sativa.

[Ask the Cannabis Nerd](#) a weekly cannabis podcast with a panel of experts answering Cannabis questions.

[Future Cannabis Project](#). Comparative Genetic Structure of *Cannabis sativa*.

[Medical Marijuana Radio](#). S12E24 Guest Dr. Anna Schwabe Cannabis Geneticists & Researcher.

[Deep Into Genetics and Biology of Cannabis](#): Global Hemp Association, with Mandi Kerr.

[The Cannabis Maker Growroom](#): With Cory Russell.

[The Age of Cannabis + Psychedelics](#) with Marc Eden: Q & A with a Cannabis Scientist, Geneticist and Educator.

[Hemp Plant Science](#): with Zosi Analytical.

[Curious About Cannabis](#): Sources of Variation in Cannabis Plants, Hope for Indica/Sativa?

With Jason Wilson.

[Cannabis Science Today](#): Can you Smell the True Blue Dream? With Emily Fata.

[The Lex Files](#): Dr. Anna Schwabe and the Gene Flow of Cannabis, with Lex Pelger.

[The Third Eye Experience](#): Dr. Anna Schwabe, with Abhinav Kumar Maurya.

[CBD Deep Dive](#): Dr. Anna Schwabe, with Dr. Jonny Lisano.

[All Things Hemp](#): Hemp Genetics with Dr. Anna Schwabe.

Skills

Laboratory: University level course development, science communication, team building and inclusion, data collection, experimental design & management, operating procedure development, data and statistical analysis, inventory management, interpersonal skills, initiative, analytical and critical thinking, collaborative projects, public speaking, leadership.

Software & Technology: Canva, Movavi, Wix, Biorender, iMovie, ChatGPT, LearnWorlds, Graphy, Canvas, Blackboard, educational materials, marketing materials, promotional material, social media content creation.

Management: inventory, team leadership, budgeting, organizing, payroll, quality control, supervising, scheduling, marketing.

Communication: science communication, college course design, grant proposals and reports, public speaking, Macintosh and PC, Microsoft Office programs (Excel, PowerPoint, Word), scientific and public presentations using PowerPoint and Prezi.

Teaching: course development (Basic Cannabis Science, Advanced Cannabis Science, Modern Cannabis Science, Conservation Biology, Anatomy & Physiology), writing syllabi, scheduling content, exam preparation, laboratory development.