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The Process and Results of Publishing Course-Embedded Undergraduate Research at Ouachita Baptist University

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SENIOR THESIS APPROVAL

This Honors thesis entitled

"The Process and Results of Publishing Course-Embedded Undergraduate Research at Ouachita Baptist University"

Written by

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and submitted in partial fulfillment of the requirements for completion of the Carl Goodson Honors Program meets the Criteria for acceptance and has been approved by the undersigned readers.

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The Process and Results of Publishing Course-Embedded Undergraduate Research at Ouachita Baptist University

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Spring 2025

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Overview of the Research and Publication Process

CURE Labs

CURE labs are Course-based Undergraduate Research Experiences (CURE). In contrast to basic laboratory sessions with pre-written protocols that align with material learned within the classroom, CURE labs are more fluid and creative for the students. Most CURE labs at Ouachita Baptist University consist of course instruction that pairs with a semester-long research project. For instance, the Biology I class's CURE lab is based on making kombucha, a project that allows students to investigate bacterial growth. This project, *miR-127/3p Inhibits Cell Migration in Lung Adenocarcinoma Under Hypoxic and Normal Oxygen Conditions,* was completed in Cell Biology during the Fall of 2023.

The Idea for Our Project

Dr. Reyna used part of the first Cell Biology lab session to allow us to brainstorm semester-long projects for our lab groups. Dr. Reyna mentioned a previous paper completed by Ouachita students, where they found that a specific molecule, miR-127/3p, correlated with a positive prognosis in breast cancer patients (Todorova, Byrum et al. 2022). Intrigued by this, our group wanted to investigate the specific effects this molecule exhibited on cancer cells. Limited by the amount of time within the semester, we decided to test the effect miR-127/3p had on cell migration of cancer cells, a common occurrence among metastatic cancers. This setup allowed us time to run multiple experiments to test for validity, as well as a primary experiment to practice our technique.

Experiments

Our experimental setup started by using breast cancer cells, but we quickly ran into trouble growing these cells. We decided to move onto glioblastoma cells, another deadly cancer, but ran into a similar problem. We finally settled on A549 Lung Adenocarcinoma cells after a few rounds of trial and error. Lung adenocarcinoma is one of the deadliest cancers, and metastasis is common within this type of cancer. With this knowledge, we found these cells to be suitable for our experimental setup.

Next, we used Cell Block Protocols produced by the Cell Biology Education Consortium to build our experiment. Cell Blocks are video protocols that students and faculty have produced to help other students learn experimental techniques. These videos include cell growth and splitting procedures, transfection protocols, data analysis, and various other techniques that students can use to build a unique experiment.

As mentioned, we first learned how to grow and split cancer cells using Cell Blocks. Next, we learned how to complete a transfection, or 'injecting' cells with specific molecules. For our experiment, we transfected cells with miR-127/3p, as well as a negative scramble microRNA to ensure the validity of our results.

As useful as Cell Blocks are, their reach is limited, and we ran into this issue when measuring and analyzing our results. We needed to develop a new technique to capture pictures of our cells at different intervals and use these pictures to obtain quantitative results that could be analyzed. This was clearly the most difficult part of our experiment but also shows the creativity and determination required to complete a CURE lab project.

We used ImageJ, a measurement software to conduct accurate measurements on the photos we took of our cells. We used a hemacytometer, a device used to count blood cells, as a scale. The grid lines on a hemacytometer were a known width, allowing us to accurately measure our cells on different days, with different microscope setups (from miscellaneous lab use).

The Limitations We Encountered

Researching as an undergraduate student brings many limitations. Even more so at a smaller institution such as Ouachita Baptist University. It is simply unreasonable to expect smaller institutions to 'keep up' with bigger institutions' budget, resources, and reputation.

CURE labs turn these limitations into creative, accessible ideas. For example, creating a hypoxic environment to grow cells in sounds like an arduous endeavor. However, out of the need for an accessible option to this issue, the hypoxic chamber was created. I have included a picture of the one we used in our experiments below.

Our lab group also needed to develop a way of consistently picturing our cells to measure our results, as mentioned elsewhere in this paper. Our CURE lab environment allowed us to be creative in solving this issue. We simply used a permanent marker to mark the spot we initially pictured, and we made sure to align the spot with the spotlight on the microscope. This allowed us to measure our results accurately and consistently. Again, our CURE lab environment created the space for us to be creative in solving the issue, which turned into an extremely useful method.

Hypoxic Chamber | Pressure gauge (left) along with a hypoxic chamber (right). The contraption functions by placing cells into the chamber, sealing the chamber, and then flooding the chamber with deoxygenated gas for a certain period.

Time was another constraint we faced as a CURE lab group. While bigger institutions and doctoral programs have years to run thousands of experiments and analyses, we had one semester to complete our project. Because of this constraint, we were required to be focused, proactive in solving issues, and communicative with each other regarding schedules and responsibilities. While some may see the time constraint as a negative aspect of CURE labs, I believe the constraint contributed to the quality of our research.

Another constraint we faced was the actual workspace of our lab. We shared a space (pictured below) with other lab groups, which forced us to be diligent in our scheduling, responsible with our time in the lab, and organized outside of the lab.

Cell Biology Lab | Located in the bottom floor of the Jones Science Center at Ouachita Baptist University. Included in the picture are the microscope (center right, covered), fume hood (right), and deoxygenated gas (left). This lab was shared between four different lab groups.

Data Analysis

Data analysis was the most complex part of the entire publication project. The task and field itself are foreign to many undergraduate students in STEM fields. However, I had not taken a statistics course yet when this project was underway.

Our group also ran into problems with the Cell Block protocols mentioned previously. There was no protocol to analyze our results obtained from our experiment, so we were forced to build a simple and strategic way to analyze our data in a way that we could understand. For that, we resorted to Google Sheets.

We devised a template that could be used to input our measurements from the photos of our cells, which subsequently calculated the averages of our measurements within each well (2 photos/well) and differences between trials, variables/treatments, and days within each experiment. From this document, we created primitive graphs that illustrated our results for the first time.

These first graphs created on Google Sheets were used during our ASCB presentation in Boston, MA, and throughout the remainder of the Cell Biology Class (including a class presentation).

As I started writing the publication, however, I needed the help of Dr. Pruett in the proper analysis of our results. Dr. Pruett teaches a statistics course at Ouachita Baptist University and is very skilled and knowledgeable in the software and language surrounding the data analytics field.

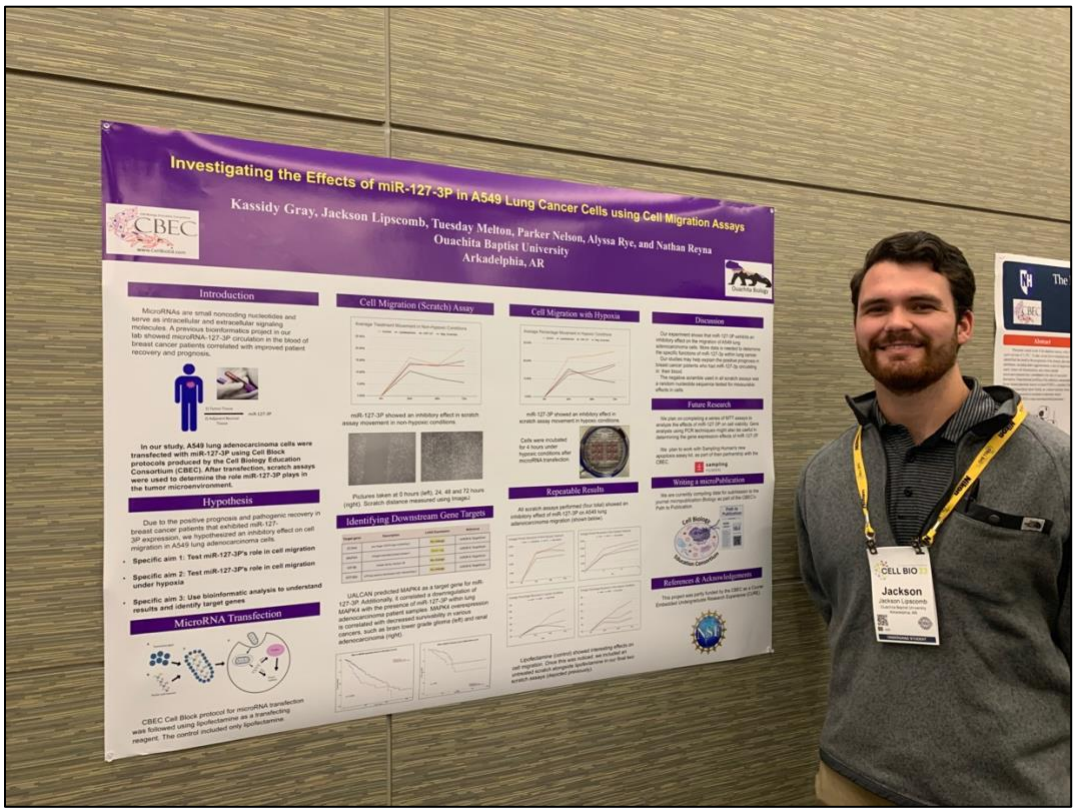
With her help, we properly analyzed our observations and tested the results using various algorithms, including a post hoc Tukey test, which is used to assess the difference between pairs of group means.

Once we achieved this analysis, and we saw that our results were significant, we moved forward with writing the actual publication, which is discussed later in this paper.

Presentation at ASCB Convention in Boston, MA

The American Society for Cell Biology hosts an annual conference for its members, and during the Fall Semester of 2023, the conference was held in Boston, MA. Our lab group was selected and sponsored by the Cell Biology Education Consortium to travel to the conference and give a presentation on our research project.

At the conference, we joined the minority of undergraduate researchers, with most of the conference comprising of doctoral and post-doctoral research. Various high-level institutions were in attendance; schools such as Stanford, UC Berkeley, NYU, Harvard, and MIT had representatives at the conference.



The 2023 ASCB Convention in Boston, MA | Jackson Lipscomb is pictured with the presentation poster during the “undergraduate research” poster session.

We presented twice at the conference, once in an “undergraduate research” poster room, and again in one of the general poster sessions. During these sessions, our group received various feedback ranging from praise and commendation to criticism and questioning. For example, while at the conference, someone criticized us for using a reagent that was considered toxic to cells, something that could very well be interacting with our results. At the time, we did not know anything about these effects, but we later went and researched the reagent we had used (as well as other ones not criticized). We found that we had used a reagent that bypassed these toxic effects and had been tested against ‘mainstream’ chemicals used in similar ways. Interactions such as these helped tremendously with proofing our research and writing the publication.

Honors Directed Study and Thesis

During the same semester I took Cell Biology (Fall 2023), I completed an Honors Directed Study focused on analyzing publications from *microPublication Biology,* a journal recognized by the NIH and *PubMed. MicroPublication Biology* consists of shorter publications, most of which have only one figure within their paper. The publications are concise, novel, and simple to follow, making it ideal for course-based research.

During this directed study, I looked at many micropublications, the people that were involved (big school vs. small school), the creativity within their project, the attributes of the experiment that were like CURE Labs at Ouachita, and contemplated if a publication could be written on the research, we were completing in Cell Biology.

The next semester, I started an honors Thesis focused on writing a manuscript for publication. This is where I recruited help from Dr. Pruitt in data analytics. Before leaving for the summer, I had a primitive outline of the paper to complete in the fall. The next fall, I enrolled in Honors Thesis hours, using the hours to complete the paper.

Learning to Write a Micropublication

Writing a manuscript for publication was a complex process, and I received advice from multiple people. I worked closely with Dr. Reyna in writing, and we often read and revised each other's thoughts.

A key aspect of scientific research that was foreign to me was citing sources. It felt unusual to cite so many times within the confines of a micropublication. In the end, I had thirteen citations within four paragraphs of my paper. In my experience in undergraduate education, lab write-ups were the only form of scientific writing I knew. This project was

completely different from that, as our experiment was novel, creative, and restricted to micropublication. There were no written protocols that we followed, but rather we built our protocol for ourselves. In this way, our CURE lab research fits more closely to published research than lab protocols for the more well-known science labs.

The writing process was by trial and error. Corrections from Dr. Reyna, reading and comparing to other micropublications, and simply rewording sentences helped tremendously. Again, there is no protocol to writing a micropublication, so this project exemplified the creativity and critical thinking that CURE lab research fosters.

Publication Process

After a semester of research and another of writing a manuscript, we finally ready ourselves to submit for publication. *MicroPublication Biology* made the process incredibly simple, and we received feedback within days. I submitted the manuscript for publication on September 16th, 2024, and was accepted for publication on October 15th, 2024, after one round of revision.

During this round of revision, we were asked to change the format of our sources and to enlarge our figure. We also found a few grammatical errors that slipped past the editing and review board.

In order to enlarge the figure and its lines, I used software that allowed me to hand draw the lines with this same color. I find this a testament to just how accessible research can be to undergraduate students with limited resources.

Publicity

After our manuscript was accepted for publication, we received publicity for our achievement. The communications department interviewed us for *The Signal*, which was then used in an Ouachita Baptist University Facebook post and an online article highlighting our research.

Through Facebook, many people learned about the project, commended our achievement, and reposted the article.

The Council for Christian Colleges and Universities also picked up our article and shared it, resulting in lots of attention for our lab group and Ouachita Baptist University.

We also presented our project at a Ouachita Baptist Board meeting, receiving questions and feedback from our university's leaders.

Lastly, I presented the project (my thesis), at Scholar's Day on April 23rd, 2025, resulting in more attention for CURE research at Ouachita Baptist University.

The Results

miR-127/3p Inhibits Cell Migration in Lung Adenocarcinoma

Under Hypoxic and Normal Oxygen Conditions

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Abstract

MicroRNAs are small noncoding nucleotides that serve as intracellular and extracellular signaling molecules. A previous collaboration found miR-127/3p circulation in the blood of breast cancer patients correlated with improved patient recovery and prognosis. While this study exclusively focused on breast cancer patients, data mining of the TCGA databases indicated that miR-127/3p may be positively associated with outcomes in other cancer types. In our study, A549 lung adenocarcinoma cells were transfected with miR-127/3p using Cell Block protocols produced by the Cell Biology Education Consortium (CBEC). After transfection, cell migration (scratch/wound healing) assays were used to determine the role miR-127/3p plays in the tumor microenvironment. To mimic and test this environment, transfected cells were incubated in normal oxygen (normoxic) and low oxygen (hypoxic) environments. We found that miR-127/3p inhibited cell migration in both normal oxygen and hypoxic environments. These results help elucidate the role miR-127/3p plays in the prevention of metastasis and further highlight its potential as a positive biomarker.

Figures

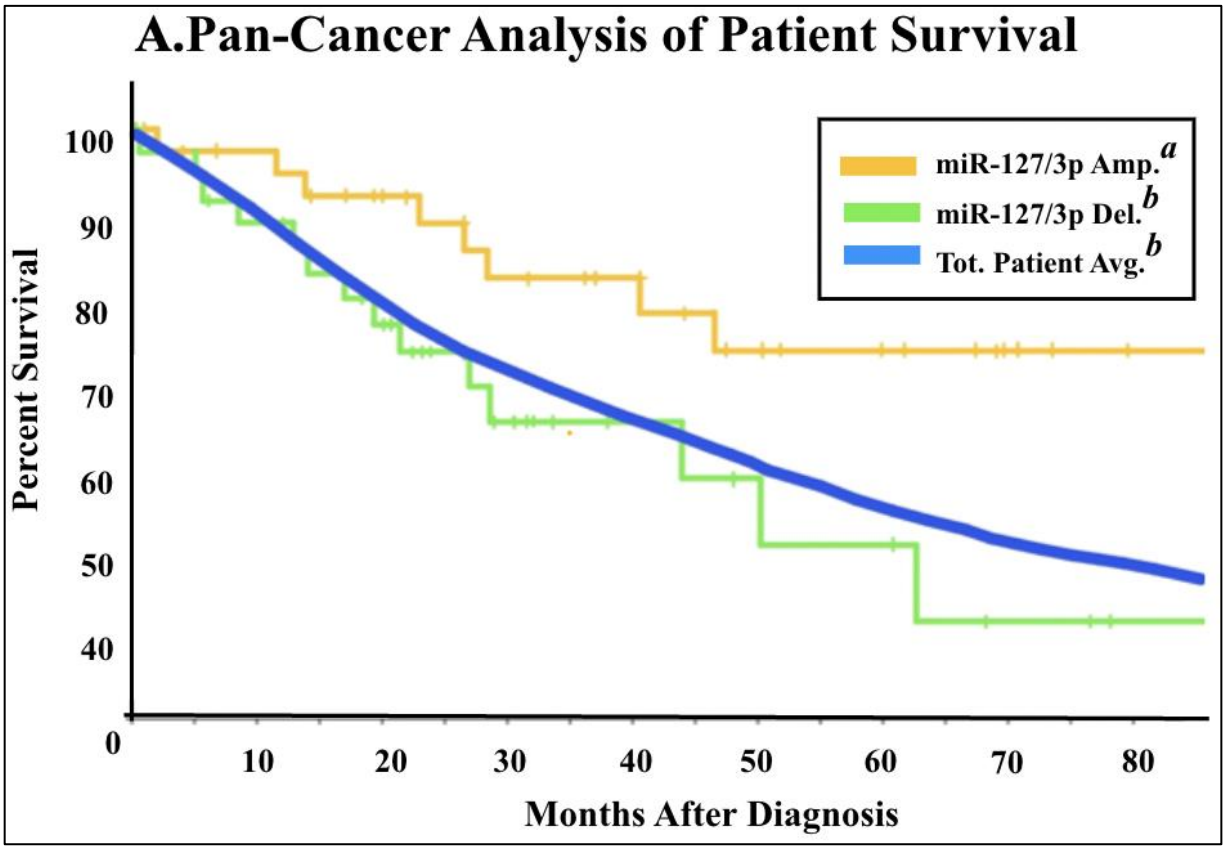
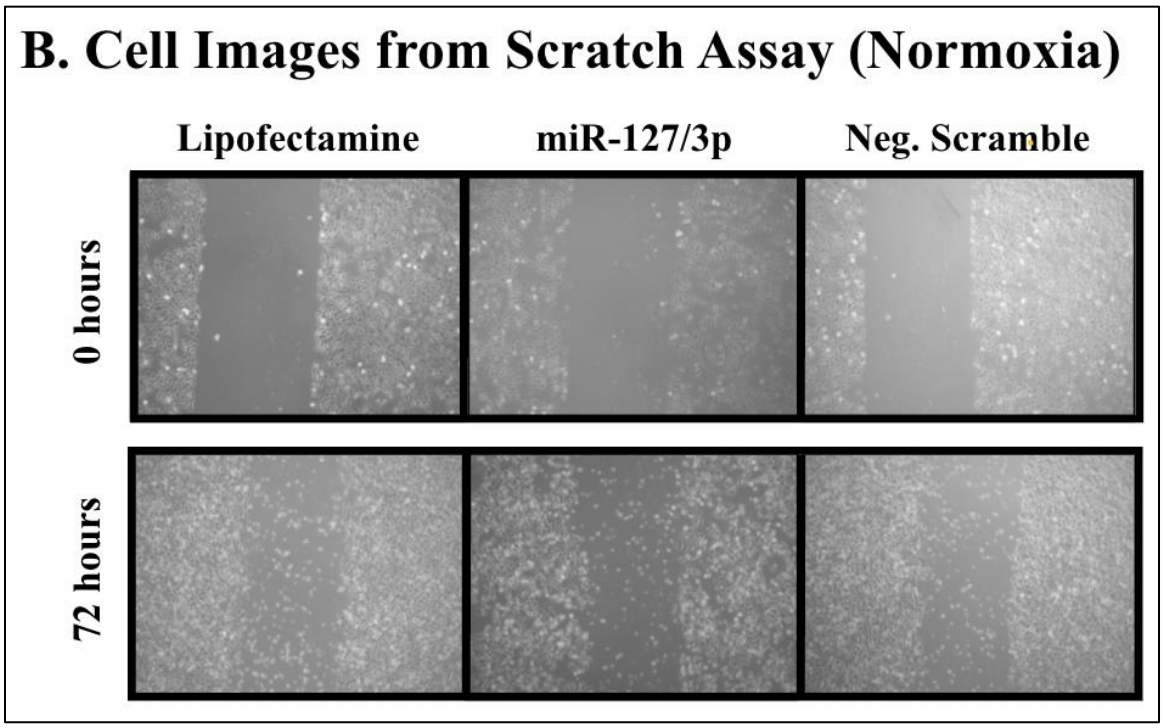
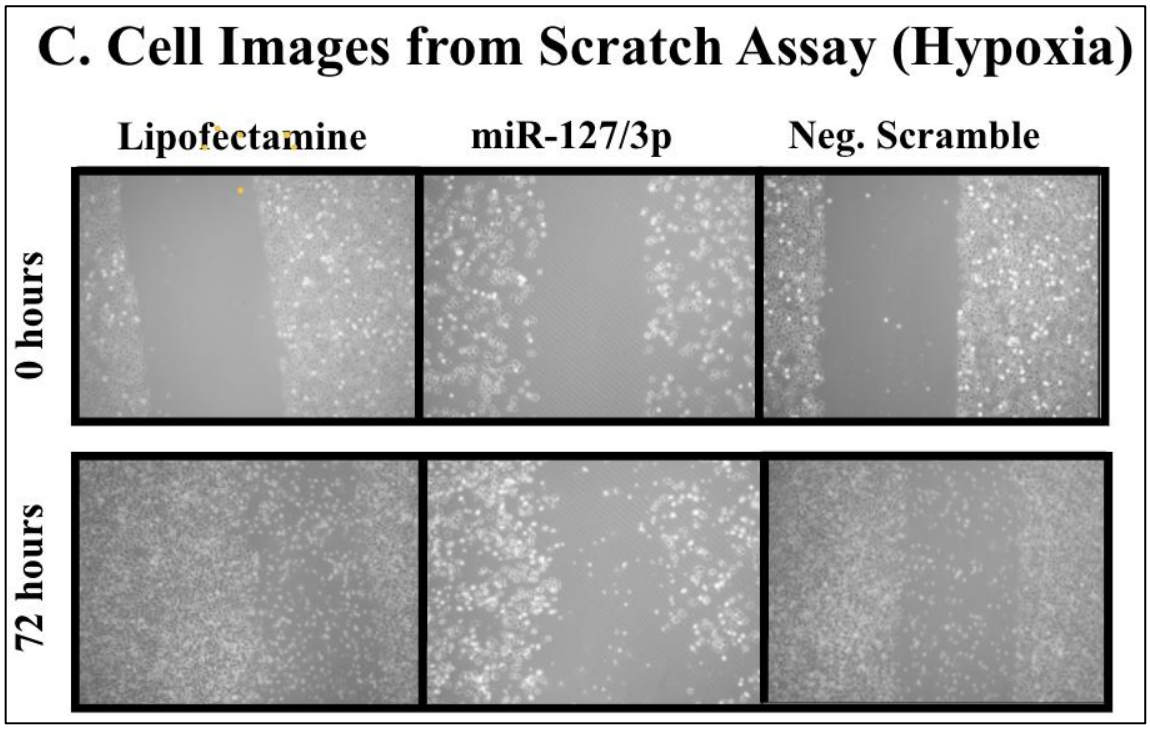


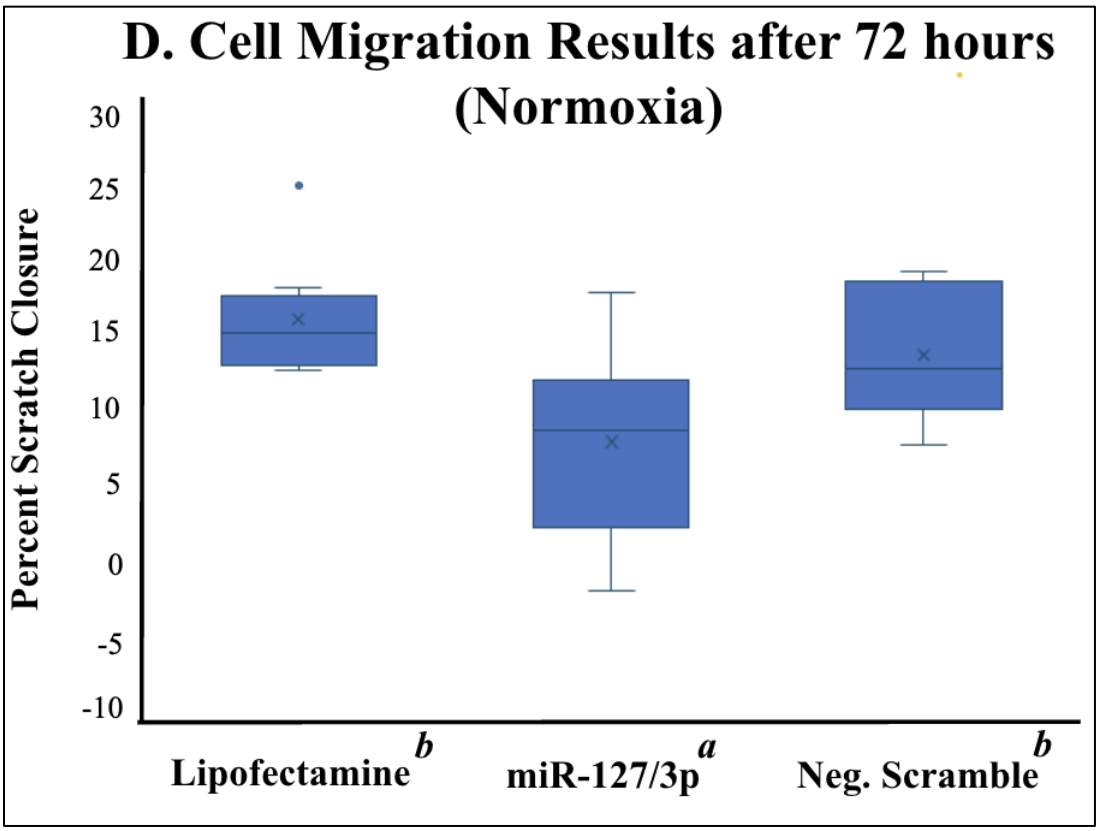
Figure A | Pan-Cancer analysis. Average survivability of all cancer subtypes (blue) compared to miR-127/3p amplification (orange) and homologous deletion (green). Amplification was statistically different from the total patient average and homologous deletion.



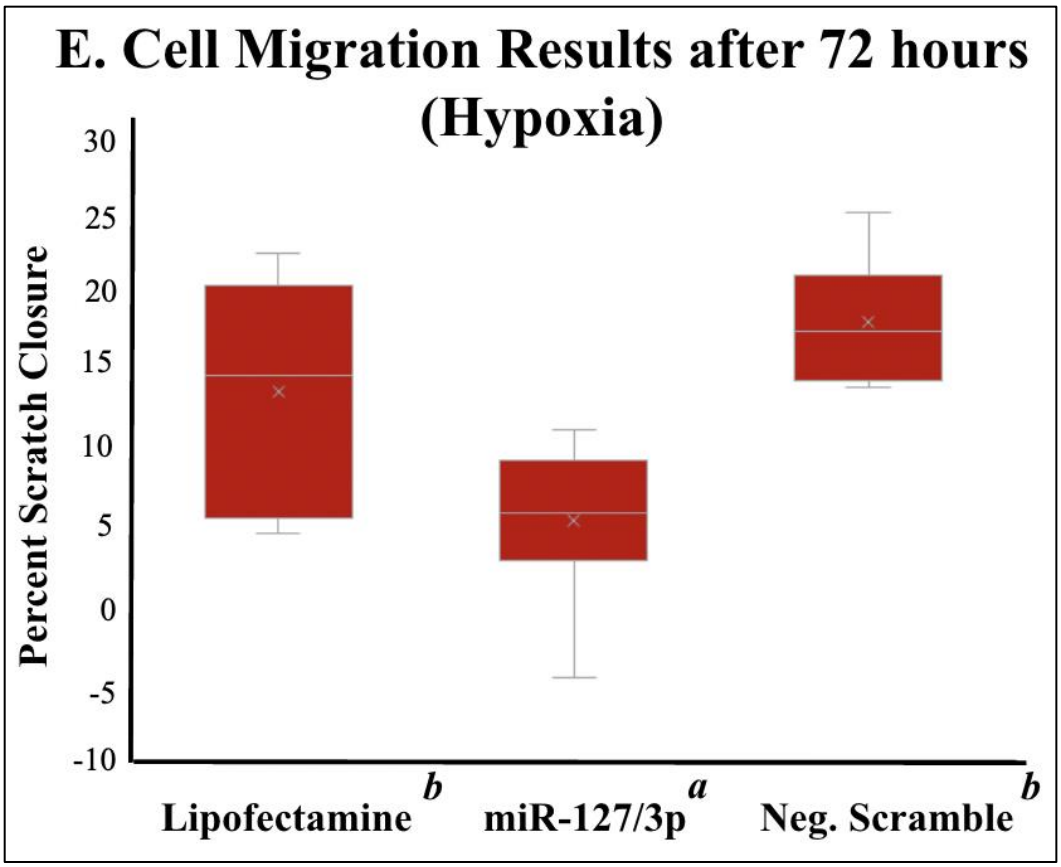
B) Cell images showing cell migration from 0 to 72 hours under normal oxygen conditions.



C) Cell images showing cell migration from 0 to 72 hours under hypoxic conditions. Pictures at 0 hours were taken after hypoxic incubation.



D) Cell migration results under normal oxygen conditions. Analysis showed miR-127/3p treatment significantly differed from the other two treatments.



E) Cell migration results under hypoxic conditions. Analysis showed that miR-127/3p treatment significantly differed from the other two treatments. No significant difference was observed between hypoxia and normoxia.

Description

MicroRNAs are short, non-coding nucleic acids, approximately 19-25 base pairs in length that regulate gene expression. MicroRNA expression analysis is becoming a newfound way to characterize cancer types (Lee and Dutta 2009). There has been growing interest in determining the prognostic role of microRNAs in lung cancer (Wani, Majid et al. 2022). Previous work in our lab found that increased levels of miR-127/3p in blood samples of breast cancer patients were associated with a favorable prognosis (Todorova, Byrum et al. 2022). Further, UALCAN analysis showed lower levels of miR-127/3p in breast cancer when compared to healthy tissue. A Pan-Cancer analysis (fig. A) revealed that lower expression of miR-127/3p in cancerous tissue is present across various cancer types. Interestingly, upon UALCAN analysis, lung adenocarcinoma (LUAD) showed considerably lower levels of miR-127/3p when compared to other cancer types.

Lung cancer is one of the most common cancer types, and LUAD accounts for a large percentage of lung cancer cases. The general prognosis for LUAD is grim, and the average life expectancy for metastasized LUAD is 12.19 months (Zhao, Gao et al. 2023). The most common sites of metastasis for LUAD are bone and other parts of the respiratory system (Riihimaki, Hemminki et al. 2014). These findings highlight the need for studies to understand the process of metastasis. To do this, our study uses wound healing (scratch) assays to measure the cell migration of lung cancer cells, a key feature of metastasized tumors (Liang, 2007).

Recently, non-coding RNAs have been found to regulate cancer cell metastasis, and they are seen as potential biomarkers in the prognosis of lung cancer (Huang, Zhu et al.

2021). Our study aims to measure the inhibitory effect of miR-127/3p on the migration of LUAD cells, an important first step in identifying miR-127/3p as a potential treatment and/or biomarker for lung cancer.

In other studies, miR-127/3p has been shown to inhibit the proliferation, migration, and invasion of triple-negative breast cancer cells by targeting various oncogenes associated with these mechanisms (Umeh-Garcia, Simion et al. 2020). Further, miR-127/3p inhibits the migration and invasion of gastric cancer cells through a similar mechanism (Wang, Wang and Jiang 2019).

To mimic the lung cancer tumor microenvironment, we included hypoxic incubation as part of our experimental setup. Reduced oxygen (hypoxia) in lung tissue is the most prominent feature of lung cancer tumors (Ziolkowska-Suchanek 2021). In as little as 30 minutes, hypoxia-induced gene expression by HIF1α leads to radiation resistance and overall aggression of cancer cells (Muz, de la Puente et al. 2015).

As reported by others, 12- to 24-hour hypoxia incubations lead to increased necrosis and cell death in lung cancer cells. (Ancel, Perotin et al. 2021) To avoid this increased cell death and necrosis, we incubated LUAD cells for four hours under hypoxic conditions. Previous work in our lab showed changes in cell morphology and physiology after four-hour hypoxia incubations without noticeable changes in cell confluency (unpublished data). Further, our study focused on early changes in gene expression, making prolonged hypoxia treatment unnecessary.

Our study used wound healing (scratch) assays to mimic the cell migration of lung adenocarcinoma (A549) cells. We evaluated the effects of transfected miR-127/3p on cell migration under both normal oxygen and hypoxic conditions.

After transfection, plated cells were scratched, and cell migration was measured at 24, 48, and 72 hours. While common trends were observed throughout the experiment, only the 72-hour mark showed statistical differences between the controls and treated samples. Under normal oxygen conditions, miR-127/3p had inhibitory effects compared to lipofectamine only ($p = 0.005$) and the scrambled microRNA negative controls ($p = 0.053$). Cells transfected with miR-127/3p showed a 13% and 11% decrease in cell migration compared to the lipofectamine and scrambled miRNA control, respectively (fig. D).

While investigating the effects of miR-127/3p under hypoxic conditions, the results followed the same patterns. Transfecting A549 cells with miR-127/3p showed significantly different migration rates as compared to the negative control ($p = 0.004$), and a moderate difference was found when compared to the lipofectamine ($p = 0.065$). Transfection with miR-127/3p showed a 11.9% decrease from the negative control and a 7.5% decrease from the lipofectamine (fig. E). For all treatments, no significant difference was observed between hypoxic and normal oxygen conditions ($p=0.365$).

In conclusion, we found an inhibitory effect of miR-127/3p on the cell migration patterns of lung adenocarcinoma cells under both normal oxygen and hypoxic environments. These results help us understand the results previously mentioned, including the positive prognosis correlating with higher levels of miR-127/3p in the blood of breast cancer patients.

Methods

This research was conducted as part of a course-based undergraduate research experience (CURE) at Ouachita Baptist University (Arkadelphia, Arkansas). All methods used for the project were "Cell Blocks" developed by the Cell Biology Education Consortium (CBEC). Cell Blocks are a series of modular written and video protocols. The flexibility of Cell Blocks allows researchers to design experiments that are of interest to them. For clarity, a link to the Cell Block used is included for each method.

Cell Culture: A549 cells (ATTC CRM-CCL-185) were grown in Dulbecco's Modified Eagle's Medium (DMEM), supplemented with 10% fetal bovine serum (FBS) and 2 mM L-glutamine for complete media. Unless otherwise noted, cells were grown in 5% CO2 at 37˚ C. CBEC Cell Growth A549 Cell Block: https://youtu.be/3Hg_LfHtY8M?si=z19lzHZcq7byi-IC

Transfection with microRNA: MiR-127/3p levels were increased in A549 cells by transfecting 50nM of the miR-127/3p mirVana™ miRNA mimic (Invitrogen) into cells. The miR-127/3p mimic was transfected into cells displaying approximately 80% confluency using RNAi-MAX transfection reagent diluted in Opti-MEM™ I Reduced Serum Medium (Gibco). As a negative control, 50nM of a negative (mirVana nonsense-scrambled) control was transfected into cells. Transfected cells were incubated under normoxic or hypoxic conditions for four hours. After incubation, cells were 'scratched.' After the scratch, the media was removed, and complete media was added to the cells. CBEC MicroRNA Transfection Cell Block: https://youtu.be/zT7Bd-SbNYY?si=0Mpg_8ki2sOe_ZJW

Hypoxia: Hypoxia was induced using a hypoxic incubation chamber (Stem Cell Technologies; catalog # 27310). The chamber was flooded for 4 min (20 PSI) with a mixed gas of 94.5 % N2, 5% CO2, and 0.5% O2 per the manufacturer's recommendations. Cells were incubated under hypoxia for 4 hours. After 4 hours of hypoxia treatment, cells were placed back into normal oxygen growth conditions. CBEC Hypoxia Cell Block: https://youtu.be/uHwonkoSdGo?si=_T8lMvoGZREtwh_H

Scratch Assay: After transfection and incubation under hypoxic or normal oxygen conditions, we scratched cell plates with a 200 µL pipette tip. For consistency in measurements, each scratch (bottom of the dish) was marked at two spots per well with a lab marker. Pictures of each marked spot were taken at 0, 24, 48, and 72 hours. To calibrate ImageJ for the measurements, a picture of a hemocytometer was taken at the same magnification. Using the known distance on the hemocytometer to set the scale, three measurements were taken for each picture (top, middle, and bottom), totaling six individual measurements for each scratch. These measurements were then averaged and used for further statistical analysis. CBEC Scratch Assay Cell Block: https://youtu.be/qbyUsSgIieU?si=FZjQzOgwOlM-S_pn

Statistics: Three biological replicates were conducted over six weeks. A minimum of two technical replicates were used each time. Normoxic and hypoxic treatments were conducted simultaneously, using cells from the same flask (passage number) for each biological replicate. Lipofectamine only and a microRNA non-sense (scrambled) sequence were used as negative controls. One-way analysis of variance (ANOVA) and post hoc Turkey's HSD tests were used to compare cell migration among treatment groups for normal oxygen and hypoxia experiments using R (R Core Team 2024).

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References

References have been placed at the end of this work.

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PubMed: 39483961

Outlines for Future Use in CURE Lab Research

The purpose of these outlines is to assist future students with designing experiments with publication as a goal. Through my work in Cell Biology and in completing this thesis, I gained valuable insight into the publishing world that I wish I would have known before I started the experiment.

That said, below are two outlines that I know will help younger students who wish to achieve the same goals I attained through my research.

Designing an Experiment for Publication Purposes

The path to publication starts at the beginning of the experiment: brainstorming. Students may find it helpful to review other micropublications from *microPublication Biology,* for inspiration. For example, our experiment centered around microRNA research and cell culture, and a simple search in *microPublication Biology* yielded dozens of similar experiments to find inspiration.

Published research usually falls into one of two categories: an experiment that tries to obtain similar results as another experiment, and an experiment that builds on a past experiment. I argue that publishing new, out-of-nowhere research is hard to write because authors must cite sources repeatedly, backing up claims they make, and follow a general outline during their paper. For example, our research built on previous research completed at Ouachita Baptist University. In this instance, we had a connection to a previous project, an interest, a novel question about our project that we could test, and a story that made sense.

During the brainstorming phase, there are a few checkpoints students should strive to meet. The experimental question should be novel, as stated previously. It should be simple, yet it should still invoke curiosity among students. I would advise students to strive for a question with obtainable results, or even a yes/no answer to the question. For example, our experiment started with the question, “What does miR-127/3p do to cancer cells?” and ended the brainstorming phase with the question, “Does miR-127/3p inhibit cell migration in (lung) cancer cells?” Our final question was novel, invoked curiosity, gave us a clearly defined goal, and allowed me, the author, to write about our results clearly and effectively.

The following is an outline for use in CURE Labs to guide the brainstorming process to eventually publish the results.

Brainstorming for CURE Lab Research Publications

For use at Ouachita Baptist University and abroad

Preliminary Questions to Ask as a Group:

1. What is this class about? (Cell Biology, Microbiology, Genetics)
2. What are we interested in? (Cancer, bacteria growth, cell migration...)
3. Has anyone else asked this question in their research (if so, what were their results, and how did they do it?)

Guidelines to Publishing Research at the Completion of the CURE Project

- Make sure the research idea is novel, or at least interesting to the group members. It does not need to be a new idea in regard to scientific research, but I would advise groups to push boundaries in what is traditionally thought of as undergraduate lab research.
- The more specific the question, the easier it will be to publish. The goal is to have specific, measurable results that clearly answer your research question. The question should not be, "What does miR-127/3p do to lung cancer?" Rather, it should be, "Does miR-127/3p inhibit cell migration in lung cancer?" In this regard, it will be easier to focus on the goal of the project and will streamline the data analysis and writing process after completion.
- Lastly, what would outside research say your results should be? If these align with your obtained results during the experiment, publishing the research will be easier. If outside research is unclear on your experiment, consider your question novel and unexplored. If outside research contradicts your results, you will have a harder time during the publishing process.

Writing and Publishing a Micropublication

The difficulty of writing a publication after the completion of a CURE project is determined by the quality of work done during the project. This is perhaps the biggest obstacle to undergraduate scientific publications. Students simply have not been exposed to complex, upper-level research long enough to know the difference between good and bad research.

CURE Labs aim to fix this however, with their master-apprentice relationships between professors and students (or groups of students). CURE Labs also force students to understand the difference between good and bad research, and they become exposed to the world of scientific research as they gain more experience within the lab.

It is certainly possible for any determined group to complete quality research viable for publication. To help future CURE lab groups, I have created another outline highlighting the steps towards publishing a project after completion in the CURE Lab. I have formatted the outline below.

The Process of Writing and Publishing Research

For use at Ouachita Baptist University and abroad

If you believe your project is a viable candidate for publication:

1. Consider the fees, time, and resources involved in writing a publication.
2. Complete a thorough analysis of all the data you have accomplished. Be certain your conclusion is supported by your data.
    a. This is the hardest part of the publication process. If you do this step well, the publication will be much easier to write. Consider asking a faculty member for help (make sure to list them as an author/contributor of the work).
3. Research the findings of similar projects or projects that support or contradict your conclusion.
    a. Every 'claim' you use to build a valid experimental setup must also be cited. Think of answers to questions like, "why did you use lung cells?" and "why did you investigate cell migration?"
4. Write the bulk of your publication. It is easier to take away information than add more later. Write the abstract last. When questioning whether to cite a source for a claim, cite a source.
5. Ask for help editing and reviewing.
    a. Eventually, your paper will be peer-reviewed for accuracy, so it is best practice to have many (expert-level) people read your work before submission. Offer to list people as contributors for their help.
6. Submit paper for publication.
    a. Eventually, you will need to submit your paper. In my experience, the review process was extremely simple, but only because I prepared well. This process may take several weeks to months to complete.
7. Publicize your work after acceptance.
    a. Let all the contributors, supporters, and faculty members know that your work was published. Your university might want to honor you and your group for your work, as it is an outstanding achievement!

The Future of CURE Lab Publications at Ouachita Baptist University

Undergraduate research is at a crossroads in history. Should institutions, especially small ones, leave the upper-level research to doctorates and professional scientists, or should we work to teach the next generation of scientists that quality research is attainable, even with limited resources?

My belief is that even undergraduate students in their preliminary science classes can achieve quality research. Even more, I believe students have the ability, the desire, and the willpower to publish their findings. My hope is that Ouachita Baptist University leads the way in empowering students to complete and publish their research in the real world.

Not only does publishing research develop students for their professional development, but it also increases the scope of scientific research in general. If research was left to top-tier institutions, and that was the only 'quality research' available, the future of scientific innovation is very constricted. However, if smaller institutions can publish quality research from students, one can only imagine the innovations, processes, and findings that will be discovered.

Aligning with Ouachita Baptist University's Vision and Mission

As previously stated, CURE labs help foster creativity and intellectual reasoning skills within students. Even more, CURE labs are a great example of how Ouachita Baptist University prepares their students for success beyond their education.

Ouachita's vision statement is "Ouachita Baptist University seeks to foster a love of God and a love of learning by creating for students and other constituents' dynamic growth opportunities both on campus and throughout the world. With foresight and faithfulness, Ouachita makes a difference" (Ouachita Baptist University, 2025). CURE labs are an incredibly practical way that Ouachita fulfills their vision. These labs are incredibly dynamic, full of creativity, and allow students to explore their world in an investigative manner.

Ouachita's mission statement is "Ouachita Baptist University is a Christ-centered learning community. Embracing the liberal arts tradition, the university prepares individuals for ongoing intellectual and spiritual growth, lives of meaningful work, and reasoned engagement with the world" (Ouachita Baptist University, 2025). CURE labs, again, are an incredible practical way of how Ouachita lives out their mission. From personal experience, CURE labs have prepared me for ongoing intellectual growth, and I feel I have made a meaningful contribution to the world of science because of my work within a CURE lab.

References

Ancel J, Perotin JM, Dewolf M, Launois C, Mulette P, Nawrocki-Raby B, et al., Dormoy V. 2021. Hypoxia in Lung Cancer Management: A Translational Approach. Cancers (Basel) 13(14).

Huang P, Zhu S, Liang X, Zhang Q, Liu C, Song L. 2021. Revisiting Lung Cancer Metastasis: Insight From the Functions of Long Non-coding RNAs. Technol Cancer Res Treat 20: 15330338211038488.

Lee YS, Dutta A. 2009. MicroRNAs in cancer. Annu Rev Pathol 4: 199-227.

Liang CC, Park AY, Guan JL. 2007. In vitro scratch assay: a convenient and inexpensive method for analysis of cell migration in vitro. Nat Protoc 2(2): 329-33.

Muz B, de la Puente P, Azab F, Azab AK. 2015. The role of hypoxia in cancer progression, angiogenesis, metastasis, and resistance to therapy. Hypoxia (Auckl) 3: 83-92.

Ouachita Baptist University. (2025, April 17). *Who We Are*. Retrieved from Ouachita Baptist University: https://obu.edu/about/who-we-are.php#:~:text=Ouachita%20Baptist%20University%20seeks%20to,faithfulness%2C%20Ouachita%20makes%20a%20difference.

Riihimäki M, Hemminki A, Fallah M, Thomsen H, Sundquist K, Sundquist J, Hemminki K. 2014. Metastatic sites and survival in lung cancer. Lung Cancer 86(1): 78-84.

Todorova VK, Byrum SD, Gies AJ, Haynie C, Smith H, Reyna NS, Makhoul I. 2022. Circulating Exosomal microRNAs as Predictive Biomarkers of Neoadjuvant Chemotherapy Response in Breast Cancer. Curr Oncol 29(2): 613-630.

Umeh-Garcia M, Simion C, Ho PY, Batra N, Berg AL, Carraway KL, Yu A, Sweeney C. 2020. A Novel Bioengineered miR-127 Prodrug Suppresses the Growth and Metastatic Potential of Triple-Negative Breast Cancer Cells. Cancer Res 80(3): 418-429.

Wang L, Wang X, Jiang X. 2019. miR-127 suppresses gastric cancer cell migration and invasion via targeting Wnt7a. Oncol Lett 17(3): 3219-3226.

Wani JA, Majid S, Imtiyaz Z, Rehman MU, Alsaffar RM, Shah NN, et al., Imam SS. 2022. MiRNAs in Lung Cancer: Diagnostic, Prognostic, and Therapeutic Potential. Diagnostics (Basel) 12(7).

Zhao Z, Gao Y, Tan F, Xue Q, Gao S, He J. 2023. Specific organ metastases and prognosis in lung adenocarcinoma. Thorac Cancer 14(8): 736-745.

Ziółkowska-Suchanek I. 2021. Mimicking Tumor Hypoxia in Non-Small Cell Lung Cancer Employing Three-Dimensional In Vitro Models. Cells 10(1).