Auburn University at Montgomery
College of Sciences
Undergraduate Research Symposium

April 29, 2022

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The Auburn Montgomery College of Sciences

Presents

The 2022 Undergraduate Research Symposium

I am thrilled to welcome you to the 2022 College of Sciences **"Undergraduate Research Symposium"** at Auburn University at Montgomery. The people of this college - the faculty, staff and students – are doing great things and represent the embodiment of a true science college. This event is one of our opportunities to showcase this fact.

We believe that the science we teach must reflect the science we do, which is why we are so focused on fostering an environment that provides all students with desired opportunities to conduct meaningful, hands-on work in their chosen field. In the sciences, this primarily means engaging in undergraduate research, whether at the benchtop, on a computer screen or in a clinical setting. But this also involves instilling in our students an entrepreneurial spirit that encourage new ways of thinking in order to identify solutions to long-standing problems. As such, the College of Sciences will work even harder in the coming years to prepare our students for STEM careers in the region and across the globe, with student-directed research playing a leading role in this effort.

So please enjoy the fruits of our students' labors and take the time to share in their contagious enthusiasm and entrepreneurial spirit as we prepare and train the next generation of problem-solvers.

Douglas W. Leaman, PhD
Professor and Dean
College of Sciences
Auburn University at Montgomery

Undergraduate Research Committee

Greg Ciesielski – Chemistry, Chair

Jerome Goddard II – Mathematics & Computer Science

John Hutchison – Chemistry

Tim Kroft – Biology and Environmental Sciences

Ann Marie O'Neill – Biology and Environmental Sciences

Hua Yan – Computer Sciences

Schedule of Events

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12:30 pm – 1:00 pm	Lunch (provided) Goodwyn Hall Lobby
1:00 pm – 1:30 pm	Keynote Speaker: Bruce F. Smith V.M.D., Ph.D. Auburn University. “Dissecting tumor biology: What molecular tools may tell us.” Goodwyn Hall 112
1:30 pm – 1:45 pm	Awards Ceremony and Closing Remarks Goodwyn Hall 112

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Poster Session II – Even Numbered Presenters

1. Investigating the role of leptin in the proliferation of ovarian cancer.

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   Department: Biology and Environmental Science

2. Kudzu invasion effects on soil seed bank and soil microbial communities might hinder native restoration

   Robert W. Kiefer *et al.* Mentors: Claudia Stein and Benedict Okeke
   Department: Biology and Environmental Science

3. Beet armyworm - does it matter if they eat native or invasive plants?

   Peyton Hope Mentor: Claudia Stein
   Department: Biology and Environmental Science

4. Bioelectricity production in soil microbial fuel cell supplemented with cellulolytic and xylanolytic bacteria

   Daveenyah Primm *et al.* Mentor: Benedict Okeke
   Department: Biology and Environmental Science

5. Evaluation of levels of indicator bacteria in water and their removal using an in-house water filter

   Kennedy Smith *et al.* Mentor: Benedict Okeke
   Department: Biology and Environmental Science

6. Selection and Molecular Characterization of Microbial Endophytes from Root Nodules for Potential Production of Biofertilizer

   Janiyah Cotton *et al.* Mentors: Benedict Okeke and Claudia Stein
   Department: Biology and Environmental Science

7. A Program of Solar Radiation and Cloud Measurements

   Thao Pham Mentor: Randy Russell
   Department: Chemistry

Poster Session I & II

Poster Session I – Odd Numbered Presenters
Poster Session II – Even Numbered Presenters

8. Proteolysis of Mitochondrial Replisome

Cody Jefferys *et al.* Mentor: Greg Ciesielski
Department: Chemistry

9. Effects of Antiviral Nucleoside Analogues on the Maintenance of the Mitochondrial Genome

Hyacintha-ghislaine M. Bisimwa *et al.* Mentor: Greg Ciesielski
Department: Chemistry

10. Implications of DNA Polymerase Gamma in the Repair of the Mitochondrial Genome

Muhamad Bedwan *et al.* Mentor: Greg Ciesielski
Department: Chemistry

11. Vision and Depth Based Trajectory Tracking for Mobile Robots

Jeffrey Deetman Mentor: Semih Dinc
Department: Computer Sciences

12. Cloud Region Segmentation from All Sky Images using Double K-Means Clustering

Thi Hong Ngoc (Kylie) Tran Mentors: Semih Dinc and Randy Russell
Department: Computer Sciences

Oral Presentation Schedule

(11:00 am – 12:30 pm)

13. Generation of a Tumour-Macrophage Model ……..... **11:00 am**

Louise Gunawan and Azura Murphy Mentor: Ann Marie O'Neill
Department: Biology and Environmental Science

14. Digitizing the AUM Herbarium: A Valuable Resource for Biodiversity Information …….~**11:20 am**

Samantha Mejia Mentor: Vanessa Koelling
Department: Biology and Environmental Science

15. Suppression of Reactive Oxygen Species by Beverages ……~**11:40 am**

Alexandra Jackson Mentor: Duk "Daniel" Kim
Department: Chemistry

16. Implications of DNA Polymerase Gamma in the Repair of the Mitochondrial Genome ……..~**12:00 pm**

Carolina de Bovi Pontes Mentor: Greg Ciesielski
Department: Chemistry

Abstracts

1. Investigating the role of leptin in the proliferation of ovarian cancer.

Lead Presenters: Azura Murphy, Louise Gunawan, Matthew Landry

Other Authors/Presenters: Linda Lewis

Mentor: Ann Marie O'Neill

Department: Biology and Environmental Science

While convincing epidemiological evidence links obesity to increased cancer growth, the underlying molecular mechanisms remain elusive. Recent studies have investigated the role of adipocyte secretions as potential mediators of accelerated growth. Metabolic dysfunction, characterized by insulin resistance, frequently accompanies obesity. In adipocytes, this causes altered adipokine secretion, including increased serum leptin levels. These changes in adipokine levels may push cancer cells to a more aggressive phenotype. The goal of this project is to investigate the effects of insulin resistant adipocytes, and in particular increased leptin levels, on proliferation of cancer cells, and if this proliferation is, in part, attributable to changes in fatty acid oxidation (FAO) in the cancer cells.

The cell lines CAOV and SKOV were treated with either conditioned media from insulin resistant adipocytes or recombinant leptin. After 48 hours, cell viability was assessed and quantitative PCR performed to determine expression of Ki67 and PCNA as markers of proliferation, and the genes CPT1, ACOX, FASN and CD36 to investigate potential differences in FAO. Our results indicated that secretion from insulin resistant adipocytes increased tumor cell proliferation, and resulted in upregulation of genes in the FAO pathway. This suggests the cells are using fatty acids as source of fuel, and this may contribute to increased proliferation.

2. Kudzu invasion effects on soil seed bank and soil microbial communities might hinder native restoration

Lead Presenter: Robert W. Kiefer

Other Authors/Presenters: Isabella Soto, Samuel Monger; Raegan Rainey, Benedict Okeke

Mentors: Claudia Stein and Benedict Okeke

Department: Biology and Environmental Science

Kudzu is one of the fastest growing and most noxious invasive plants in the US. As a legume, it strongly influences not only carbon and nitrogen dynamics but likely also the available species pool in the soil seed bank and soil microbial composition. Alterations to the soil microbial community can hinder the establishment of desired native plants that often require specific soil microorganisms. We present preliminary results from 1) a seed bank study assessing how kudzu affects the availability of seeds in the soil and 2) a greenhouse study testing how soil microbes associated with kudzu affect growth of plants native to Black Belt Prairies.

Our results indicate that kudzu decreased the diversity and abundance of species in the seed bank. Further, especially native legumes produced lower biomass when grown with soil microbes associated with kudzu. We found weak support for the hypothesis that soil microbes from intact native communities provide a benefit for native plant establishment. Our next steps are to isolate and identify microbes associated with kudzu and to assess species-specific effects. Applying active intervention strategies that supplement the species pool in the seed bank and reverse soil microbial changes seem critical for the restoration of kudzu-invaded ecosystems.

3. Beet armyworm - does it matter if they eat native or invasive plants?

Lead Presenter: Peyton Hope

Mentor: Claudia Stein

Department: Biology and Environmental Science

Invasive species present major threats to native biodiversity and they often disrupt plant-animal interactions that co-evolved in the native ranges. We test the hypothesis that generalist herbivores, which feed on a variety of different plant species, are better adapted to native vs invasive plants. We will present results from laboratory feeding experiments, testing if development of a generalist herbivore, Spodoptera exigua also known as the Beet armyworm, differs depending on what plant species the larvae are feeding on. We are using eight different plant species, four of them are invasive and four of them are native to Alabama. If development of the larvae is slower on a diet consisting of invasive plants compared to native plants this would indicate that the invasive plants might contain novel secondary compounds that might inhibit the growth of the herbivore.

4. Bioelectricity production in soil microbial fuel cell supplemented with cellulolytic and xylanolytic bacteria

Lead Presenters: Daveenyah Primm, Katrina Vance, JoAnna Sheffield, Olivia Taylor and Kennedy Smith

Other Authors/Presenters: Ryan Loomis, Meghan Frazier, Andrea Barnett and Janiyah Cotton

Mentor: Benedict Okeke

Department: Biology and Environmental Science

Microbial fuel cells deploy microbial metabolism of nutrients in anaerobic environments to produce electricity by releasing electrons from nutrients. In a microbial fuel cell (MFC) the electrons are captured by the anode and travel to the cathode where electrons reduce oxygen to water. The ability of microbes to produce electricity by this mechanism has gained increasing attention. Evolution of modern technology and unique equipment enabled validation of the theory of microbial production of electricity. A notable example is the microbial fuel cell (MFC) in which electrochemically active microorganisms transfer electrons for bioelectricity production.

In this study we have deployed the MudWatt MFC to screen soils for presence of electrochemically active microbes that produce bioelectricity. Lignocellulose biomass is an abundant natural resource that can be hydrolyzed to sugars for bioelectricity production. Facultative anaerobic bacteria isolated from the soil samples were first tested for production of cellulase and xylanase in a complex lignocellulose biomass medium. Higher cellulolytic and xylanolytic activities were present in microbes isolated from soils producing bioelectricity in the MFC. Selected cellulolytic and xylanolytic bacteria from soil were evaluated for potential augmentation of bioelectricity production in the soil microbial fuel cell. In further studies, we will evaluate bioelectricity production in MFC with a defined microbial consortium, scale up of the MFC, and explore using it to charge mini device battery.

5. Evaluation of levels of indicator bacteria in water and their removal using an in-house water filter

Lead Presenters: Kennedy Smith, Shallom Kim and Daveenyah Primm

Other Authors/Presenters: Ryan Loomis, Jasmine Walker, Brady Waller, Thinh Q Truong and Jada Mack

Mentor: Benedict Okeke

Department: Biology and Environmental Science

Poor water quality is a global problem especially in rural communities and in the time of crisis impacting clean water supply. Water is a major necessity of life and presence of pathogens in water can result to transmission of diseases. Levels of coliforms (indicator bacteria) in water signals potential presence of pathogens.

Aspects of this study assessed levels of water quality indicator bacteria in a community recreational lake water using the IDEXX Colilert method. All water samples displayed significant numbers of total coliforms and the coliform bacterium Escherichia coli. Two in-house water filters designated "Scalable Reusable Adsorption Matrix Assemblage (S-RAMA) were evaluated for the removal of bacteria from contaminated water. The prototype water filters consisted of different layers of adsorption media in ordered array, including celite, gravel, sand, and charcoal. Initial test on microbial removal by the filter using IDEXX Colilert revealed substantial removal of indicator organisms from contaminated water. This suggests the filter can be optimized for efficient removal of pathogens from water. Further studies will focus on a water treatment process that will incorporate a coagulation step upstream and a disinfection step downstream the water filter to produce clean water.

6. Selection and Molecular Characterization of Microbial Endophytes from Root Nodules for Potential Production of Biofertilizer

Lead Presenters: Janiyah Cotton and Andrea Barnett

Other Authors/Presenters:

Mentors: Benedict Okeke and Claudia Stein

Department: Biology and Environmental Science

The need to reduce the use of synthetic chemicals as fertilizers and pesticides in agriculture has received increasing attention. Rhizobial and non-rhizobial root nodule endophytes play major roles in plant growth promotion through nitrogen fixation, nutrient solubilization, disease resistance and production of biochemicals such as auxins, gibberellin and enzymes.

In this preliminary study, potential beneficial bacteria were isolated from surface sterilized root nodules of the rapidly growing Pueraria montana (Kudzu), Trifolium repens and Chamaecrista fasciculate. The isolates were identified using GenBank BLAST analysis of the sequence of the 16S rRNA gene, amplified with universal primers 27F and 1492R. Bacterial isolates from P. montana root nodules were identified as Bacillus, Arthrobacter, Paenarthrobacter, and Pedobacter species. The most abundant isolate from P. montana was Bacillus species (99.68% identical to Bacillus megaterium and Bacillus acidiceler). Bacillus and Rhizobium species were isolated from C. fasciculate. The Rhizobium isolate was 98.63% identical R. leguminosarum and R. anhuiense. Rhizobium, Bacillus and Enterobacter species were isolated from T. repens nodules. The Rhizobium isolate from T. folium root nodules was 99.37% identical to R. sophorae, R. leguminosarum and R. indigoferae.

Further studies will focus on isolating Rhizobium species from root nodules of P. montana and evaluation of plant growth promotion with selected isolates. Some of the identified bacterial genera (Bacillus, Rhizobium, and Enterobacter species) have been reported to promote plant growth. Use of biofertilizers can reduce over dependence on chemical fertilizers which can cause environmental and health problems.

7. A Program of Solar Radiation and Cloud Measurements

Lead Presenter: Thao Pham

Mentor: Randy Russell

Department: Chemistry

A program for measuring direct and diffuse solar irradiance and cloud cover was established on the AUM campus. Measurements of global solar irradiance using a newly calibrated radiometer were used to calibrate a second radiometer. One radiometer was mounted on a shadow ring to measure diffuse solar irradiance, and the other was mounted on a mast to measure global irradiance. Hemispherical images of the sky were taken using a camera mounted on the top of the AUM library tower. Several days of observations were made under both clear sky and cloudy conditions. The presentation will discuss the calibration of the radiometers and compare the irradiance data with a simple clear-sky model for global and diffuse solar irradiance. A method for estimating cloud cover from hemispherical sky images will also be discussed.

8. Proteolysis of Mitochondrial Replisome

Lead Presenter: Cody Jefferys

Other Authors/Presenters: Carolina de Bovi Pontes, Muhamad Bedwan, Monia Yousef, Elena J. Ciesielska

Mentor: Greg Ciesielski

Department: Chemistry

Defects to the mitochondrial genome are associated with numerous human disorders. The primary deletions of mitochondrial (mt)DNA are the most common, de novo, defects, but their etiology remains elusive. We recently proposed that the primary deletions may be induced by frequent stalling of the mtDNA replication machinery. Furthermore, we propose that in normal conditions, mtDNA replication stalling events may be mitigated by a dedicated replisome elimination machinery, composed of molecular chaperones and proteases.

Here we present an in vitro investigation of the capacity of selected molecular chaperones and proteases to degrade mtDNA replication factors. Thus far, our results indicate that proteolysis of the mitochondrial DNA polymerase entails a cooperative action of the proteases and chaperones, which together disassemble and degrade the holoenzyme. These results reveal a novel aspect of the maintenance of the mitochondrial genome.

9. Effects of Antiviral Nucleoside Analogues on the Maintenance of the Mitochondrial Genome

Lead Presenter: Hyacintha-ghislaine M. Bisimwa

Other Authors/Presenters: Elena J. Ciesielska, Noelle Kim

Mentor: Greg Ciesielski

Department: Chemistry

The outbreak of the COVID-19 pandemic prompted the search for effective antivirals. Remdesivir was the first nucleoside analogue approved by the FDA for COVID-19 treatment, and recently the FDA has authorized the use of another analogue, molnupiravir. Mitochondrial toxicity, resulting from the interference with mitochondrial DNA (mtDNA) replication, is the most common side effect of nucleoside analogues treatment. Here we present an assessment of the effect of remdesivir on the maintenance of the mitochondrial genome. We observed that in in vitro DNA synthesis assays, its triphosphate metabolite may impede the synthetic activity of the mitochondrial replicative polymerase, Pol γ, when in excess over nucleotides. Prompted by this finding, we tested the effect of the nucleoside metabolite of remdesivir on the maintenance and integrity of the mitochondrial genome in proliferating fibroblasts. However, we found no evidence for deleterious effects of remdesivir on the integrity of the mitochondrial genome. In addition, we performed an analogical assessment of the effects of molnupiravir on the integrity of the mitochondrial genome. Thus far, we have observed that, unlike remdesivir, molnupiravir is cytotoxic for proliferating fibroblasts and results in a decrease in mtDNA copy number.

10. Implications of DNA Polymerase Gamma in the Repair of the Mitochondrial Genome

Lead Presenters: Muhamad Bedwan, Monia Yousef

Other Authors/Presenters: Carolina de Bovi Pontes, Elena J. Ciesielska

Mentor: Greg Ciesielski

Department: Chemistry

Mitochondrial DNA (mtDNA) encodes thirteen essential proteins of the oxidative phosphorylation system, responsible for the major production of ATP in the cell. Therefore, damages to the mitochondrial genome result in energy deprivation, which may in turn onset human diseases. Notably, mtDNA remains exposed to damage by reactive oxygen species, thus the maintenance of its integrity requires a robust repair system. Until recently, DNA polymerase gamma (Pol γ) has been the only polymerase identified in mitochondria, bearing responsibility for efficient replication as well as post-replication repair of the genome. Recently, the major repair polymerase of the nucleus, Pol β, has been discovered to also localize in mitochondria, which raises the question for its competition or cooperation with Pol γ in the mtDNA repair processes.

To address this, we have tested in vitro the efficiency of DNA synthesis by the two polymerases, separately and in combination, using various DNA substrates. We observed a cooperative activity of Pol β with the catalytic subunit of Pol γ. Therefore, in conclusion, our results suggest that the repair of mtDNA may entail a synergistic activity of the catalytic subunit of Pol γ and Pol β.

11. Vision and Depth Based Trajectory Tracking for Mobile Robots

Lead Presenter: Jeffrey Deetman

Mentor: Semih Dinc

Department: Computer Sciences

Vision-based trajectory tracking using a camera system mounted on a mobile robot has been a challenging problem. In such tracking systems, the robot/camera system is required to follow a desired trajectory for relative position and orientation (pose) with respect to a target object. In typical outdoor applications, the actual pose of robot is measured by a Global Positioning System (GPS). However, GPS is not practical for indoor applications. In such cases, the pose error may be calculated using vision-based approaches.

In this study, we explore fast and reliable vision-based target tracking system. We first created simulation models to create trajectories and tracking experiments using the python programming language. We have built the robotic vehicle using a iRobot Create 2 kit, Intel RealSense LiDAR Camera L515, and a Raspberry Pi 4 for the control module. Currently we work on implementation of simulated experiments on the actual robotic vehicle. We have reached promising results during the initial experiments.

12. Cloud Region Segmentation from All Sky Images using Double K-Means Clustering

Lead Presenter: Thi Hong Ngoc (Kylie) Tran

Mentor: Semih Dinc and Randy Russell

Departments: Computer Sciences and Chemistry

The cloud region segmentation is one of the major problems in the atmospheric cloud research, where the cloud regions in a sky image are segmented to determine their density and location. This is a challenging task because of vague and indistinct cloud boundaries and translucent thin cloud patterns.

In this study, we propose a lightweight and unsupervised methodology to identify cloud regions on a ground-based sky image. Our method offers a fast and adaptive segmentation approach without a necessity of fixed thresholds by utilizing a K-means based clustering approach on transformed pixel values. In the first step, pixels are clustered into three groups as clear sky, indeterminate, and cloud. In the second step, only indeterminate pixels are clustered into clear sky and cloud. In the final step, we apply a median based spatial filtering approach to eliminate mislabeled and isolated pixels. We have experimented our method in two datasets. The results showed that the proposed method achieves high segmentation accuracy without the need of fixed thresholding or tedious supervision process.

13. Generation of a Tumour-Macrophage Model

Lead Presenters: Louise Gunawan, Azura Murphy

Other Authors/Presenters: Linda Lewis, Matthew Landry

Mentor: Ann Marie O'Neill

Departments: Biology and Environmental Science

Metastatic disease is the cause of mortality in 90% of solid tumors, yet the underlying mechanisms whereby a cancer cell from a primary tumor travels to and colonizes a distant site have not yet been fully elucidated. While cell-cell fusion occurs as a normal and essential cellular process, aberrant cell fusion has been linked to disease, including metastatic cancer. The cell fusion hypothesis was first put forward over 100 years ago by Professor Otto Aichel, a German pathologist, and has gained traction in recent years. The central tenet is that the fusion of tumor cells with bone marrow derived cells (BMDCs) may enhance the metastatic potential of the tumor cells due to changes in the gene expression pattern in the fused cell resulting from the addition of the BMDC nucleus, thus generating cells that are both motile and capable of continuous cell division.

While the evidence above provides convincing evidence for macrophage tumor fusions as potentiators of metastatic disease, much remains unknown about the post-hybridisation gene activation driving events leading to this phenotype. The mechanisms by which hybrid cells activate genes that enhance cell migration remains unresolved, and has been identified as an important area for investigation as a potential target for therapy. In order to conduct these investigations, it is necessary to first establish a model that can be utilized to conduct further investigations. Using the macrophage cell line RAW264.7, transfected to express GFP (RAW-GFP), and the colorectal cancer cell line HT-29 transfected to express RFP (HT-29 RFP), we will recapitulate conditions of the tumour microenvironment to generate cancer-macrophage fusion hybrids. Once the hybrids are established, we will then have a model in which to compare the phenotype and function of these cells to the parental tumor cells, HT-29 RFP.

14. Digitizing the AUM Herbarium: A Valuable Resource for Biodiversity Information

Lead Presenter: Samantha Mejia

Mentor: Vanessa Koelling

Departments: Biology and Environmental Science

Herbaria represent important repositories of historical biodiversity information. Most herbaria are small and have not yet been digitized and made accessible to the global scientific community in public databases, meaning that the information they contain is known only to a small number of scientists with direct access to the herbarium. Here we report how we digitized AUM's small herbarium of around 1,000 specimens and uploaded specimen information to public biodiversity databases so that it is accessible to researchers outside of AUM. We also describe the contents of the herbarium collection, including number of species, genera, and families represented, as well as map the collection location of specimens. We also identify gaps in the collection to better guide future collection efforts.

15. Suppression of Reactive Oxygen Species by Beverages

Lead Presenter: Alexandra Jackson

Mentor: Duk "Daniel" Kim

Departments: Chemistry

The intake of water, either plain water or beverage, is a necessary means of hydration for a healthy human life. The reactive oxygen species, mainly produced in mitochondrial activities in the human body, are related to aging, cancer initiation, and various neurologic disorders. It is known that many organic ingredients in commercial beverages contain a variety of different types of antioxidants. Suppression of Reactive Oxygen Species (ROS) by beverage was investigated in this study by using ultrasonic irradiation to the commercial beverage containing waters. Fluorometric measurement was applied to measure the amount of hydrogen peroxide and organic peroxides in water after the ultrasonic irradiation. An interesting general trend of significant suppression from dark-colored beverages was observed in this study. This study will help the general public understand how drinking beverages may reduce the health risk caused by unavoidable ROS in the human body.

16. Implications of DNA Polymerase Gamma in the Repair of the Mitochondrial Genome

Lead Presenter: Carolina de Bovi Pontes

Other Authors/Presenters: Muhamad Bedwan, Monia Yousef, Elena J. Ciesielska

Mentor: Greg Ciesielski

Department: Chemistry

Mitochondrial DNA (mtDNA) encodes thirteen essential proteins of the oxidative phosphorylation system, responsible for the major production of ATP in the cell. Therefore, damages to the mitochondrial genome result in energy deprivation, which may in turn onset human diseases. Notably, mtDNA remains exposed to damage by reactive oxygen species, thus the maintenance of its integrity requires a robust repair system. Until recently, DNA polymerase gamma (Pol γ) has been the only polymerase identified in mitochondria, bearing responsibility for efficient replication as well as post-replication repair of the genome. Recently, the major repair polymerase of the nucleus, Pol β, has been discovered to also localize in mitochondria, which raises the question for its competition or cooperation with Pol γ in the mtDNA repair processes.

To address this, we have tested in vitro the efficiency of DNA synthesis by the two polymerases, separately and in combination, using various DNA substrates. We observed a cooperative activity of Pol β with the catalytic subunit of Pol γ. Therefore, in conclusion, our results suggest that the repair of mtDNA may entail a synergistic activity of the catalytic subunit of Pol γ and Pol β.