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understanding of the mechanisms mediating glucose homeostasis to accelerate the identification of new medications to prevent conversion to T2D. Recent reports indicate that former obesity medication, 5-hydroxytryptamine (5-HT, serotonin)2C receptor (5-HT2CR) agonist lorcaserin improves glycemic control in association with weight loss in obese patients with T2D. We examined whether lorcaserin has a direct effect on insulin sensitivity and how this effect is achieved. We clarify that lorcaserin dose-dependently improves glycemic control in a mouse model of T2D without altering body weight. Examining the mechanism of this effect, we reveal a necessary and sufficient neurochemical mediator of lorcaserin's glucoregulatory effects, via activation of brain pro-opiomelanocortin (POMC) peptides. We observed that lorcaserin reduces hepatic glucose production and improves insulin sensitivity. The recent large scale clinical trial CAMELLIA-TIMI 61 revealed that lorcaserin prevented conversion to T2D and improved T2D and supports the translational relevance this medication for prediabetes and T2D treatment. We also found that lorcaserin requires GLP-1 neurons in the brain to produce its effects, and the combination of lorcaserin boosts GLP-1 receptor drug semaglutide's effects on food intake and glucose tolerance. Taken together, these data suggest that lorcaserin's action within the brain represents a mechanistically novel treatment for prediabetes and T2D: findings of significance to a prevalent global disease.

Symposia

Symposium 1: Reproductive Physiology

Symposium 1.1: Short-Term Disruption of The Circadian Rhythm may Cause Tissue-Specific Changes in The Ovaries And Uterus in Mice

Aylin Yaba Uçar

Yeditepe University Faculty of Medicine Department of Histology and Embryology, 34755, Istanbul, Türkiye

The circadian rhythm is integral to reproductive competence, governing critical physiological cycles in the female reproductive system. This study aimed to comprehensively investigate the impact of short-term circadian rhythm disruption (CRD) on both the mouse ovary and uterus, focusing on the mediating roles of the Hippo signaling pathways (YAP1/TEAD4) and mTERT (mouse telomerase catalytic subunit).

Female Balb/c mice (6-8 weeks old) were divided into control (12:12 h Light/Dark, LD) and experimental (12:12 h Light/Light, LL) groups for one week of CRD. Ovarian and uterine tissues were analyzed using morphological methods, follicle counting, immunofluorescence (core clock protein PER2, YAP1, TEAD4, and mTERT), and qRT-PCR (circadian clock genes, YAP1, TEAD4, and mTERT).
We investigated CRD induced rapid and tissue-specific pathological and molecular changes in ovary and uterus. In the ovary, LL exposure resulted in structural impairment, a significant reduction in primordial follicle count, and an increase in atretic follicles. CRD caused a decrease in PER2. Furthermore, ovarian Hippo signaling proteins showed a distinct imbalance with a decrease in YAP1 and, an increase in TEAD4 and mTERT protein expression. In the uterus, CRD led to a reduction in luminal epithelial and myometrial thickness alongside an increase in endometrial glands and luminal diameter. Uterine molecular analysis showed a concurrent elevation of YAP1 and TEAD4 protein levels, and a reduction in mTERT protein. mRNA levels of circadian clock genes BMAL1, CLOCK, PER2, and CRY1 remained largely unchanged.

These findings identify that short-term CRD impairs reproductive function in female mice through the differential dysregulation of key intracellular pathways Hippo signaling and mTERT in the ovary and uterus. Therefore, we suggested that Hippo signaling and mTERT may be a potential therapeutic targets for CRD-related infertility and reproductive disorders during working night shifts, disrupted sleep patterns, and jetlag.

Symposium 1.2: The Role of Humanin Peptide in the Regulation of Male Reproductive Physiology

Sinan Canpolat

Firat University, Faculty of Medicine, Department of Physiology, Elazığ, Türkiye

Puberty and reproductive functions are shaped by a complex mechanism involving the interaction of hormones, the central nervous system, reproductive organ development, and various metabolic processes. The body's energy reserves and metabolic status play a critical role in the onset of puberty, acquisition of reproductive capacity, and fertilization. Physiological mechanisms controlling energy balance are closely linked to those regulating reproduction, thereby optimizing reproductive success. Mitochondria, which play a crucial role in energy metabolism, have multiple functions that vary across species. These include the production of energy required for gametogenesis and fertilization, as well as the regulation of apoptosis to ensure proper gamete production.

This study investigated the effects of the Humanin peptide on puberty onset, reproductive system development, sexual behaviors, and central regulation of reproduction in male rats. The research was conducted in three phases. In

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the first phase, humanin administration accelerated puberty onset, regulated reproductive hormone levels, shortened the time to sexual maturation, and improved spermatological parameters. In the second phase, an antidepressant-induced sexual dysfunction model was established using Paroxetine. Humanin treatment improved sexual behavior parameters, increased serum hormone levels, and enhanced sexual motivation by strengthening dopamine release, as confirmed by immunohistochemical analyses. Spermatological examinations further supported its restorative role. In the third phase, microdialysis measurements in healthy animals demonstrated that humanin administration partially increased dopamine release in the nucleus accumbens, although this increase did not reach statistical significance.

In conclusion, these findings indicate that humanin plays a modulatory role in male reproductive physiology, positively influences sexual behaviors, and may have therapeutic potential in the regulation of spermatogenesis.

Symposium 1.3: Intracellular pH Regulation During Embryogenesis

Şeref Erdoğan

Çukurova University, Medical Faculty, Department of Physiology, Adana,Türkiye

The intracellular pH (pHi) regulating system consists of two major components: the HCO_3^-/Cl^- exchanger (AE) for alkalosis, and the Na^+/H^+ exchanger (NHE) and sodium-dependent HCO_3^-/Cl^- exchanger (NDBCE) for acidosis. Interestingly, the pHi regulatory mechanism established during oogenesis is inhibited during meiotic maturation. However, this inhibition is released upon the formation of the pronuclear zygote, marking the completion of meiotic maturation. At this pronuclear (PN) stage, the activities of AE, NHE, and NDBCE become fully functional.

As embryonic development progresses from the PN stage to the trophoblast stage, AE activity gradually declines. In contrast, the activities of NHE and NDBCE remain relatively stable. Furthermore, these developmental patterns in pHi regulator activity are consistent regardless of whether the embryos develop in vivo or in vitro. The distinct regulation of these pHi regulators during preimplantation development is considered an adaptive response to the increasing metabolic demands of the developing embryo and its transition from the alkaline environment of the fallopian tube to the acidic milieu of the uterus.

This presentation will summarize research findings from the past two decades on the developmental dynamics of intracellular pH regulators, a fundamental homeostatic mechanism in embryogenesis. This knowledge improves our understanding of both in vivo and in vitro embryonic development, and is positioned to contribute to the refinement and effectiveness of IVF applications.

Symposium 2: Multidisciplinary Approach in Cancer Treatment

Symposium 2.1: Current Developments in Multidisciplinary Approach in Oncology

Beste Atasoy

Marmara University School of Medicine, Department of Radiation Oncology, Istanbul, Türkiye

Cancer is currently the second leading cause of death worldwide and impacts human life. The main components of definitive and palliative cancer treatment approaches are surgery, radiotherapy, and systemic treatments. With advances in technology, the likelihood of achieving a cure, symptom control, and palliation has increased with these primary treatment methods. However, the costs of these treatments are high. Furthermore, in patients who are cured, late side effects after treatment are burdensome, difficult to manage, and costly, leading to a decrease in quality of life. For all these reasons, new topics and research across different disciplines are being studied to contribute to survival and improve the quality of life. "Nutritional oncology" and "exercise in oncology" are developing areas with their own guidelines and are candidates for inclusion in evidence-based guidelines, which oncology professionals frequently refer to as roadmaps. Collaboration among medical specialties in the management of cancer treatment continues in daily practice through consultations, tumor boards, and the principle of a treatment team. Malnutrition and sarcopenia, associated with muscle loss, are proven to be poor prognostic factors in almost all cancer patients. These preventable factors can be controlled through cancer nutrition teams. A nutrition team may include, in addition to physicians, a registered dietitian, a dentist, the patient's caregiver, a psychologist, a nutrition nurse, hospital food services, a pharmacist, a physiotherapist, and other specialists from various disciplines. A team effort, whether within this team or under a separate heading such as a "Movement and Exercise Team," seems worthwhile for developing new standards in cancer management. All efforts that bring together different disciplines are open to research. Because cancer is a chronic disease, and as an African proverb says, "If we want to go fast, we can go alone. However, if we want to go far, we must go together."

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Symposium 2.2: Exercise as Part of Cancer Treatment

Özgür Kasımay

Marmara University School of Medicine, Department of Physiology, Istanbul, Türkiye

Cancer and exercise research has gained momentum in the last 20 years and has become the focus of attention today. Over the past decade, an interdisciplinary bridge has been established involving oncologists, sports physicians, physiologists, physical therapists, and exercise specialists, resulting in over 2,000 publications annually. The findings of these studies aim to further advance the shared understanding that exercise serves as a “medicine” in cancer prevention, during treatment, and in the post-treatment period. Exercise Guidelines for cancer patients have been created based on the results of studies conducted on common cancers such as breast, colon, esophagus, stomach, kidney, bladder, and endometrial cancer, and include exercise recommendations for these types of cancer. To prevent cancer, it is recommended to engage in moderate-intensity aerobic exercise involving major muscle groups for 150 to 300 minutes per week and/or high-intensity aerobic exercise for 75 to 150 minutes per week on most days of the week. For cancer patients, aerobic exercise sessions involving major muscle groups for 30 to 60 minutes, 3 days a week, are recommended. For resistance exercise, prescriptions involving 2 sets of 8-12 repetitions, 2 days a week, are take attention. There is strong evidence regarding chronic structured exercise program to improve quality of life, to suppress anxiety and depression, to improve physical capacity and function, to alleviate fatigue, and to reduce lymphedema. There is moderate evidence regarding its effects on bone health and sleep patterns. Exercise recommendations for brain tumor patients have not yet been included in guidelines, and studies related to the creation of exercise prescriptions are ongoing. In a randomized controlled prospective study conducted by our research group, combined aerobic and resistance exercise that was conducted during radiotherapy of patients who had undergone brain tumor surgery increased cardiopulmonary fitness and muscle strength, improved quality of life, and reduced fatigue. In our study on glioblastoma animal model, aerobic exercise was found to improve cognitive and motor function and reduce anxiety- and depression-like behavior. Developing a practical roadmap for integrating exercise programs, which have numerous positive effects, including reducing cancer-related mortality, into treatment plans through personalized exercise prescriptions will be achieved through a multidisciplinary approach.

Symposium 2.3: Effects of Exercise on the Tumor Microenvironment

Aslı Nur Bahar

Department of Physiology, Faculty of Medicine, Marmara University, Istanbul, Türkiye

The tumor microenvironment (TME) is a dynamic structure shaped by the interaction of blood vessels, stromal cells, immune components, and metabolic products. Within this microenvironment, abnormal vascularization, hypoxia, and irregular blood flow facilitate tumor growth and resistance to therapy. Exercise emerges as a powerful physiological stimulus that improves vascular function, regulates blood flow and oxygenation, and normalizes the microenvironment by reducing vascular permeability. Moreover, cancer-associated muscle wasting (cachexia/sarcopenia) is one of the major determinants of morbidity and mortality in cancer patients. Exercise not only preserves muscle mass but also enhances the endocrine function of muscle by increasing myokine secretion, thereby modulating inflammation, angiogenesis, and metabolic balance within the TME.

The accumulation of reactive oxygen species (ROS) in the TME plays a key role in cellular damage, angiogenesis, and proliferation. This oxidative stress–dominant environment promotes tumor cell growth and invasion while reducing treatment response. In our experimental glioblastoma model, the observed outcomes support mechanisms related to oxidative stress and inflammation. The pronounced oxidative and inflammatory response in the tumor microenvironment (TOS, OSI, MDA, MPO) was reversed by exercise; notably, the exercise protocol initiated after tumor induction strongly activated antioxidant defenses and restored redox balance. These findings indicate that exercise is not only preventive but also an effective physiological intervention capable of reestablishing redox homeostasis by reducing microenvironmental stress even after tumor development. In this presentation, we will discuss how exercise modulates blood flow to influence the structural and functional characteristics of the tumor microenvironment (TME); how muscle–tumor interactions are regulated through myokine-mediated signaling pathways; and how hypoxia, acidosis, and lactate dynamics, together with the accumulation of reactive oxygen species (ROS), reshape the TME. These processes will be examined in the context of current literature.

Symposium 3: Mitochondrial Transplantation and Transfer: A New Approach to the Treatment of Diseases ''From Methods to Mechanisms''

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Symposium 3.1: Mitochondrial Transplantation: A New Approach to the Treatment of Diseases — From Methods to Mechanisms

Gökhan Burçin Kubat

Başkent University, Faculty of Health Sciences, Department of Exercise and Sports Sciences, Ankara, Türkiye

Mitochondrial Transplantation (MT) is an innovative approach that aims to restore cellular energy homeostasis by isolating healthy mitochondria and transplanting them into damaged cells or tissues. Mitochondria play critical roles not only in intracellular energy production but also in apoptosis, oxidative stress response, and the regulation of cellular signaling pathways. Therefore, the prevention of mitochondrial dysfunction is of great importance in the treatment of various degenerative, metabolic, and ischemic diseases.

Mitochondrial isolation is one of the key steps determining the success of MT. In cell culture and preclinical studies, isolation procedures are typically performed using differential centrifugation, gradient centrifugation, or commercial isolation kits. However, in clinical applications, mitochondria are generally isolated autologously (from the patient's own tissues), most commonly from the gastrocnemius, pectoralis major, or vastus lateralis muscles, under rapid and hypothermic conditions. The primary aim of these procedures is to preserve mitochondrial integrity and maintain their functional viability.

MT can be administered through different routes. In both clinical and experimental studies, the most commonly preferred method is direct injection into the target tissue. In addition, alternative routes such as systemic intravenous delivery, intranasal administration, and, more recently, oral administration have also been investigated. Preclinical studies conducted in various disease models including cardiac ischemia, cerebral stroke, liver injury, kidney injury, and skeletal muscle atrophy have reported that MT accelerates tissue regeneration, reduces oxidative stress, and enhances cell viability.

The dosage of mitochondria varies depending on the type of experimental model and the size of the target tissue. Although a wide range of dosage regimens has been reported in the literature, the optimal dose required to achieve clinical efficacy has not yet been standardized. Furthermore, the cellular uptake mechanisms, bio-distribution dynamics, and long-term stability of transplanted mitochondria are still under investigation. Current findings suggest that mitochondria are internalized by cells through endocytosis-like mechanisms and can be functionally integrated into cellular metabolism.

At the clinical level, clinical trials have demonstrated that MT significantly improves tissue function following cardiac ischemia. Similarly, our team's initial clinical study on wound healing has yielded promising results, and additional clinical trials involving different patient groups are currently ongoing. These findings support the potential of MT to be incorporated into standard therapeutic protocols in the future.

In conclusion, MT represents a therapeutic strategy that regulates energy metabolism, reduces oxidative stress, and enhances cellular regeneration. However, for successful clinical application, it is essential to identify the most suitable tissue or cell sources, optimize isolation conditions, and determine appropriate dosage ranges. Ongoing research aims to establish MT as an effective therapeutic option for aging, neurodegenerative, and metabolic diseases, offering a novel and promising perspective in disease treatment.

Symposium 3.2: The Potential Role of Mitochondrial Transplantation in Skeletal Muscle Health and Exercise Performance

Ibrahim Turkel

Hacettepe University, Faculty of Sport Sciences, Department of Exercise and Sport Sciences, Ankara, Türkiye

Maintaining mitochondrial function, which is responsible for energy production through oxidative phosphorylation and referred to as the cell's powerhouse, is crucial not only for skeletal muscle health but also for the maintenance of metabolic homeostasis. Beyond their role in cellular energy production, mitochondria are critically involved in several biological processes, including thermogenesis, calcium regulation, production of reactive oxygen species (ROS), and programmed cell death. On the other hand, impairment of mitochondrial quality control mechanisms, such as mitochondrial biogenesis and mitophagy, has been associated with sarcopenia, metabolic diseases, and reduced exercise tolerance. Therefore, optimization of mitochondrial function is vital for both metabolic health and exercise performance.

The structural and functional plasticity of skeletal muscle is an important feature that allows adaptation to various physiological stimuli. During exercise, cellular changes (such as energy production and ROS production) impose significant stress on mitochondria. To adapt to these exercise-induced changes and sustain muscle contraction, a series of structural and functional adaptations occur in the mitochondria, contributing to the beneficial effects of exercise on health and performance.

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In recent years, mitochondrial transplantation (MT) has emerged as an innovative therapeutic strategy based on the principle of isolating healthy and functional mitochondria from cells and tissues and transplanting them into cells and tissues exhibiting mitochondrial dysfunction. Transplantation of healthy mitochondria contributes to the reorganization of energy metabolism, reduces oxidative stress, and thereby preserves cellular homeostasis.

Several preclinical studies have demonstrated that MT can prevent skeletal muscle atrophy and damage. Across different models of muscle atrophy and damage, MT has been reported to increase muscle cross-sectional area, enhance the levels of proteins associated with oxidative phosphorylation, and reduce ROS production. Significant increases have also been observed in the levels of key molecular regulators of exercise performance, such as peroxisome proliferator-activated receptor gamma coactivator-1 alpha (PGC-1α), a master transcription factor of mitochondrial biogenesis, and adenosine monophosphate-activated protein kinase (AMPK), the key enzyme of energy metabolism. Moreover, MT has been shown to improve physical activity levels and exercise performance in aged animals. These findings suggest that MT may serve not only as a therapeutic strategy for myopathies but also as a potential approach to enhance athletic performance through the optimization of skeletal muscle adaptation.

Symposium 3.3: Mitochondrial Transplantation Restores Energetic Function and Protects the Rat Heart Against Myocardial Injury and Dysfunction

Erkan Tuncay

Ankara University, Faculty of Medicine, Department of Biophysics, Ankara, Türkiye

Cardiac injury and contractile dysfunction following ischemic stress are driven primarily by mitochondrial damage, loss of bioenergetic capacity, and excessive oxidative stress. Mitochondrial transfer and transplantation (MTT) have emerged as a novel therapeutic strategy to restore cellular energetics and promote cardiac recovery; however, the essential requirements for mitochondrial integrity and the mechanisms underlying its protective effects remain to be fully defined. The aim of this study is to investigate the role of MTT in improving cardiac dysfunction and its effects on energy metabolism following ischemic injury.

In this study, mitochondria were isolated from mesenchymal stem cells and their integrity confirmed using biochemical analyses, confocal microscopy, and transmission electron microscopy. MTT experiments were conducted under live-cell confocal imaging to visualize the uptake and incorporation of donor mitochondria into recipient cells. Intracellular free Ca^{2+} concentration, mitochondrial membrane potential (MMP), and reactive oxygen species (ROS) levels were measured using fluorescence-based assays, while total protein expression was assessed by Western-blot analysis.

In the Langendorff-perfused rat heart model subjected to ischemia and reperfusion, delivery of functional mitochondria at the onset of reperfusion significantly improved left ventricular developed pressure($p<0.05$), while non-functional mitochondria failed to enhance recovery, confirming the necessity of viable, polarized mitochondria. Complementary experiments in isolated cardiomyocytes exposed to hypoxia–reoxygenation demonstrated that MTT restored MMP, reduced ROS, improved ATP generation, and normalized intracellular Ca^{2+} handling($p<0.001$). Additionally, MTT enhanced glucose uptake and increased GLUT4 protein surface expression ($p<0.05$), indicating improved metabolic flexibility and energy substrate utilization.

Together, these findings demonstrate that mitochondrial transplantation effectively restores myocardial energetics, mitigates oxidative damage, and preserves contractile and metabolic function. This work highlights MTT as a promising mitochondria-targeted therapeutic strategy to prevent cardiac injury and dysfunction (Supported by Ankara University BAP Project TSG-2024-3309).

Symposium 3.4: Mitochondrial Transplantation: Current Debates and the Search for Solutions

Oner Ulger

Department of Mitochondria and Cellular Research, Gulhane Health Sciences Institute, University of Health Sciences, Ankara, Türkiye

Mitochondrial transplantation (MTx) is a novel method that has emerged in recent years and shows promising results. It serves as a commendable example of endeavors to identify solutions for a range of diseases that present treatment challenges, including toxic tissue damage, wound healing, and neurodegenerative diseases, particularly those involving ischemic damage to heart and brain tissue. A number of the findings obtained in preclinical studies have been corroborated by clinical research, thus initiating discussions on MTx as a new treatment option. This method is briefly carried out by isolating healthy functional mitochondria and delivering them to damaged tissue/cells. This process enables the augmentation of healthy mitochondria and the regulation of specific mechanisms. Nevertheless, there are still some issues that require

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resolution. The elimination of these issues is imperative for the advancement of the MTx method. In this context, an examination of difficulties which await resolution can be undertaken under three headings:

1. Issues related to the MTx technique: In this context, topics currently being examined include certain points requiring improvement in the mitochondrial isolation method, the maintenance of mitochondria after isolation, the method of delivering exogenous mitochondria to target tissues/cells, dosages, duration of effect, and the selection of the mitochondrial source to be used for isolation.

2. Behavior of transplanted mitochondria: The fate of mitochondria post-transfer to the target organism, the manner of their entry into cells, their behavior within cells and how they affect mitochondrial dynamics, the retention time of exogenous mitochondria within recipient cells, the mechanisms by which beneficial effects are produced, and the duration of these effects are among the topics that require investigation.

3. Transferring to clinical protocols: To apply for therapeutic purposes, the efficacy of the MTx approach must first undergo rigorous evaluation through testing on human or animal patients under a range of conditions and across multiple centers. This evaluation must encompass critical considerations such as rapid and efficient isolation, meticulous source selection, precise dosage, treatment duration, and delineation of the duration of effects, to ensure the reliability of the approach and determine its optimal clinical utility. Defining the principles for obtaining the necessary permissions for clinical research is another critical stage. Another important issue that should be the establishment of a legal framework and ethical principles for the clinical applications of the MTx.

Resolving these issues requires systematic collaboration between different research centers to conduct preclinical and clinical studies. Defining common terminology and standard operating principles is crucial to ensure methodological consistency and reproducibility. Despite the highly promising findings, it is considered that further progress will be difficult without resolving these issues

Symposium 4: The Lifestyle Medicine: A Journey from Student Training to Clinical Research

Symposium 4.1: Integrating Lifestyle Medicine into Medical School Curriculum

Mehtap Kaçar

University of Yeditepe, Faculty of Medicine, Department of Physiology, Istanbul,Türkiye

Lifestyle medicine is a holistic medical approach based on behavioral change, focusing on the individual's daily living habits to protect health and prevent chronic diseases. Lifestyle medicine is built on fundamental elements such as healthy eating, regular physical activity, adequate sleep, stress management, reducing substance use, and strengthening social ties. Currently, lifestyle medicine is regarded not only as a core component of preventive medicine but also as an essential element of treatment processes, and is considered within the framework of 'the medicine of the future.' With this approach, lifestyle medicine acts as a bridge between various fields of medicine and health sciences by addressing areas such as physical activity, nutrition, stress management, addictions, and sleep hygiene.

The elective clerkship “Lifestyle Medicine (MED553)”, integrated into the 5th-year curriculum of Yeditepe University Faculty of Medicine, aims to incorporate this approach into medical education. The course content covers both theoretical and practical aspects of topics such as the core principles of lifestyle medicine, behavioral change techniques, exercise prescription, sleep, nutrition, stress management, and substance use. Throughout this rotation, students acquire the knowledge and skills necessary to integrate the fundamental components of healthy living into clinical practice.

Since the 2024–2025 academic year, the clinical elective course “Lifestyle Medicine (MED553)” has been implemented to evaluate changes in students’ knowledge and attitudes. These changes are assessed using pre-tests and post-tests administered at the beginning and end of the rotation. Overall, the feedback obtained has been highly positive, indicating that students find the course beneficial in terms of both content and practical application. This program evaluation suggests that lifestyle medicine education can become a sustainable and expandable component of the medical school curriculum.

Symposium 4.2: Motivational Interviewing in Clinical Research: Exercise and Psychosocial Dimensions

Burçin Tuvana Us

University of Yeditepe, Faculty of Medicine, Department of Physiology, Istanbul, Türkiye

Motivational interviewing is an evidence-based counseling approach aimed at enhancing an individual's intrinsic motivation for behavior change. In the context of lifestyle medicine, it is particularly utilized to promote adherence to physical activity and to support the sustainability of healthy living habits. Within this framework, experiences and observations related to the implementation of motivational

interviewing are shared as part of a TÜBİTAK 1001-funded project investigating the efficacy of different types of exercise in individuals with non-alcoholic fatty liver disease. During the project, participants received individualized exercise prescriptions and attended regular motivational interviewing sessions. In these sessions, individuals' readiness to change, perceived self-efficacy, and behavioral commitment levels were systematically assessed. Observations from the project suggest that motivational interviewing serves as a supportive approach for exercise adherence and facilitates the process of behavioral change. In this study, the general framework of motivational interviewing applications, observational findings, and the integration of this approach into the research process are discussed. The role of this approach, which combines physiological and psychosocial evaluations, in providing a holistic perspective on lifestyle-based interventions is also examined.

This study was supported by The Scientific and Technological Research Council of Türkiye (TÜBİTAK) (Project No: 321S513).

Symposium 4.3: Effects of Exercise on Liver Steatosis and Related Parameters

Meltem Yalçın Oğuz

University of Yeditepe, Faculty of Medicine, Department of Physiology, Istanbul, Türkiye

Non-alcoholic fatty liver disease (NAFLD) is a prevalent liver disorder characterized by triglyceride accumulation within hepatocytes in the absence of significant alcohol consumption and it is closely associated with obesity, insulin resistance, and metabolic syndrome. In the management of NAFLD, lifestyle modification—particularly increasing physical activity and implementing structured exercise programs—represents a cornerstone of therapy. However, studies that comprehensively examine the effects of different exercise protocols on hepatic steatosis and related metabolic parameters remain limited.

In this presentation, findings from our TÜBİTAK project supported by the ARDEB 1001 Program - Special Call for Sports Research will be discussed. The project investigates the effects of 12-week HIIT, resistance, and FATmax exercise protocols on liver steatosis, and associated physiological, biochemical, and psychosocial outcomes. Furthermore, the effects of exercise on skeletal muscle-derived signaling molecules known as myokines (myonectin, myostatin, L-BAIBA, musclin) and their potential as biomarkers of exercise responsiveness will be evaluated.

Our findings indicate that HIIT, resistance, and FATmax exercise protocols exert therapeutic effects on liver health and related metabolic mechanisms. The type of exercise and the degree of adherence were found to influence myokine responses, suggesting that these molecules may serve as potential biomarkers reflecting the effectiveness of exercise therapy in NAFLD. These results contribute to a better understanding of the physiological basis of exercise therapy in NAFLD, support the identification of biomarkers representing exercise-induced metabolic adaptations, and promote the development of personalized, evidence-based exercise strategies within the framework of lifestyle medicine.

This study was supported by The Scientific and Technological Research Council of Türkiye (TÜBİTAK) (Project No: 321S513).

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Panels

Panel 1: Investigation of the Human Brain Physiology by Means of Electrophysiology and Functional Imaging Methods

Panel 1.1. Functional Magnetic Resonance Imaging (fMRI) Approaches for the Analysis of Brain Functions

Tamer Demiralp

Department of Physiology, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Türkiye

While neural activities in the brain generate real-time electrical signal changes, they also lead to slower hemodynamic responses as a result of neurovascular coupling. Investigating these processes at the whole-brain level or across large neural circuits is crucial for understanding the large-scale organization of the brain that is closely related to behavior. In this context, alongside electroencephalogram (EEG) and electrocorticogram (ECoG) methods, which reflect synchronized neuronal population activities with high temporal resolution, magnetic resonance imaging (MRI) plays an important role by providing high spatial resolution of the structural properties of gray and white matter as well as hemodynamic changes in the brain.

This presentation will address the physiological foundations of the blood oxygen level-dependent (BOLD) signal, which forms the basis of functional MRI (fMRI) measurements and is grounded in the mechanisms of neurovascular coupling. Subsequently, the applications of the BOLD signal in examining neural activations in the brain and functional connectivity between brain regions will be explained. In this framework, intrinsic connectivity networks (ICNs) will be reviewed, which demonstrate patterns of functional connectivity ongoing during the “resting state” when no specific task is being performed. The emergence of task-dependent neural activation and connectivity changes on the basis of this ongoing activity will be discussed.

Panel 1.2: Cortical Mapping and Cortico-Cortical Evoked Potentials

Sacit Karamürsel

Koç Üniversitesi School of Medicine Department of Physiology, Istanbul, Türkiye

In the majority of drug-resistant epilepsy patients for whom surgical treatment was indicated, 10 to 18 depth electrodes were stereotactically implanted into brain regions suspected to be seizure foci, based on seizure semiology, neuroimaging modalities (MRI, PET, SPECT), and scalp EEG analyses. These electrodes were strategically positioned to target areas with high epileptogenic potential, including the temporal, frontal, parietal, and insular cortices.

Patients were admitted to the video EEG monitoring unit for prolonged observation, initiating the process of invasive electrophysiological evaluation. For cortical mapping purposes, electrical stimulation trains were delivered to various electrode contact pairs using currents ranging from 1 to 15 mA, pulse widths between 100 and 500 μs, and durations spanning 100 to 2000 ms at a frequency of 60 Hz. These stimulations were employed to assess both the induction of interictal spike-wave activity and the proximity of the stimulated regions to eloquent cortex. Motor and sensory (visual and auditory) responses, as well as cognitive functions such as language, comprehension, and memory, were evaluated with active patient participation.

Additionally, Cortico-Cortical Evoked Potentials (CCEPs) were recorded by delivering single-pulse electrical stimuli at 1 Hz for 30 seconds to cortical areas presumed to be near or distant from the seizure focus. These recordings were analyzed based on both individual responses and averaged potentials, providing insights into the topographic organization of epileptogenic networks and guiding surgical targeting strategies.

This work was supported by the TÜBİTAK 123S085 and the TÜSEB B-22405 projects.

Panel 1.3: Investigation of Regional Neurodegeneration and Distributed Network Dynamics in Alzheimer's Disease using Magnetic Resonance Imaging

Emre Harı

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The neurodegeneration pattern in Alzheimer’s disease (AD) leads to progressive disruption of connectivity across multilayered brain networks. In this context, neuroimaging findings highlight the importance of network integrity disturbances in understanding different disease stages. Accordingly, studies from our laboratory using magnetic resonance imaging (MRI) have examined neural network alterations along with local atrophy patterns from a holistic perspective across AD stages.

In our analyses focusing on the Papez circuit, which plays a central role in episodic memory formation, we found that functional MRI (fMRI) connectivity between the retrosplenial and parahippocampal cortices was already affected at the preclinical stage. The ventral cingulum

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connecting these two key nodes of the Papez circuit was markedly impaired as the disease progressed to dementia. Therefore, degenerative changes in this white matter bridge—where limbic tau pathology and neocortical amyloid pathology converge—correspond to an advanced phase of cognitive decline. Examination of the thalamus, a less-studied structure in AD, revealed that connectivity between the medial thalamic nuclei and the rostral frontal cortex was disrupted during the transition to the prodromal stage, while in the dementia stage, these same nuclei showed significant atrophy.

While circuit-level studies play a key role in understanding the neural processes underlying the clinical course of AD, identifying subcortical and limbic regions where neurodegeneration begins is crucial for early diagnosis. In this context, our volumetric analyses revealed that, unlike the traditional focus on the hippocampus, the amygdala is more prominently affected in early stages. Moreover, reduced connectivity between the amygdala and frontal areas, correlated with memory decline, highlights the early role of amygdala degeneration.

In conclusion, examining focal anatomical patterns of early neuropathological changes is essential for developing biomarkers for early diagnosis, while analyzing structural and functional connectivity alterations within neural circuits provides insights into the neural basis of cognitive decline in AD.

Panel 1.4: Object and Scene Perception Processes in the Human Brain

Ulaş Ay

Istanbul University, Hulusi Behçet Life Sciences Research Laboratory, Neuroimaging Unit, Istanbul, Türkiye

Along the ventral visual stream of the human brain, object-selective regions analyze the structural and identity-related features of objects, whereas scene-selective regions located in the parahippocampal, retrosplenial, and occipitoparietal areas represent spatial context. The meanings of objects are influenced by the scene context in which they are embedded, while scenes are defined through the objects they contain. Within this framework, we aimed to investigate, by means of functional magnetic resonance imaging (fMRI), the functional relationships and interactions of localized object- and scene-selective regions with other brain areas.

In the first study we conducted within this framework, we examined the resting-state functional connectivity of object-selective visual areas, namely the lateral occipital (LO) and posterior fusiform (pF) cortices. Our analyses showed that the LO regions exhibited strong connections both with early visual areas and with the parietal cortex and frontal attention networks, whereas the pF regions were strongly related to temporal and limbic areas in both hemispheres. This pattern indicates that the LO interacts with systems related to attention and action while analyzing the structural features of objects, whereas the pF represents object identity in a more semantic and memory-based manner. As a result, our findings reveal that during object perception, different object-selective regions establish distinct patterns of communication with attention, action, and memory networks.

In another study in which we tested the effect of context on perception, we reduced the salience of object or scene components of the visual input through blurring and examined the interaction between object and scene perception. Our results showed that when object salience was reduced but scene context was preserved, brain activation expanded in the occipitotemporal and parietal regions, whereas when scene salience was reduced, activation was limited to frontal areas. These findings show that when object information weakens, the stronger engagement of parietal and occipitotemporal regions indicates that spatial cues provided by the scene are utilized. In contrast, when contextual information becomes uncertain, the brain can no longer rely on environmental cues and instead engages higher-level prediction and decision-making processes.

In conclusion, although object and scene perception begin in different subsystems of the human brain, the maintenance of visual coherence depends on the integrated interaction of these two subsystems, and our fMRI measurements demonstrate that this integrative process can be mapped onto specific neuroanatomical structures. This study was supported by The Scientific and Technological Research Council of Türkiye (Project number: 122S654)

Panel 2: Utilizing Active Learning Methods and Artificial Intelligence in Physiology Education

Panel 2.1: Using active learning methods in physiology education: Examples on shock pathophysiology, exercise physiology, and movement control.

Selma Arzu Vardar

Department of Physiology, Faculty of Medicine, Trakya University, Edirne, Türkiye

In teaching physiology, it has become essential to seek methods that facilitate learning and ensure lasting learning. Active student-centered educational strategies are

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frequently used to develop skills in recalling information, analyzing it, and using it to solve problems when necessary. It has been noted that knowledge is more retentive when students are actively involved in learning.

In elective courses, student-centered educational strategies can often be applied. Decreased blood flow in the body reduces the delivery of oxygen and nutrients to tissues and cells, leading to the development of circulatory shock. Circulatory shock exceeding a critical level causes tissue destruction, decreased cardiac output, and tissue perfusion disorders that can lead to death. Topics related to shock pathophysiology can be addressed as an elective course using case-based methods, integrating disciplines such as emergency medicine, cardiology, infectious diseases, neurology, anesthesia, intensive care, and physiology. Student feedback on an elective course on the pathophysiology of shock, designed using active learning methods, indicated that students were generally satisfied with this elective course (68%), describing it as engaging and encouraging research.

Exercise physiology elective courses, designed to examine the cardiovascular, circulatory, and respiratory system responses and the maintenance of metabolic functions in the body under exercise conditions, can be planned as exercise test applications, case-based studies, problem-based sessions, student-prepared presentations, or simulations. The detailed planning of such student-involved activities includes preparing an introductory booklet and pretest and posttest questions.

Active learning methods can be implemented in the theoretical physiology lessons. For example, during a two-hour lecture on motor control of movement in the body, students can solve problems, engage in group discussions about the questions they answer, and review a case report on the topic. Using active learning methods can be beneficial for gaining experience in applying physiological knowledge, as well as enhancing motivation and communication skills.

Panel 2.2: A New Elective Course at the Faculty of Medicine: Robophysiology

Ethem Gelir

Ankara Medipol University, Faculty of Medicine, Department of Physiology, Ankara, Türkiye

Increasing the impact of technology, especially electronics and software, on the medicine, requires the education of medical doctors using these technologies to be revised. It is necessary to make some changes in training for the students to understand and use the technology that they use in medicine and to develop new technologies. While it was not possible for medical doctors to intervene in hardware and software before, developments in software and hardware technology have made it possible in recent years. The development in the software is the spread of the "Python" programming language. The development in hardware is the widespread use of the "Arduino" microcontroller (which can be thought of as a very small and inexpensive computer fitted to a chip). The course, which I started at Hacettepe Faculty of Medicine for the first time in 2017-2018 education year under the name of "Mathematical Physiology" covers these topics. Next year this 16 week elective course (2 hours/week) expanded and given in two terms under the names of "Robophysiology I: Arduino" and "Robophysiology II: Python".

Through these lessons, I aim to make medical school students understand the working principle of the instruments used for medical diagnosis and treatment. It is also the goal of this course to ensure that students who complete this course will be able to develop a new medical tool as well as gain the ability to perform both physical and mathematical models of specific physiological systems.

The reason for choosing Python language in software is very easy to learn because it is very similar to English grammar and spoken language. Despite being easy, it is pretty powerful. According to the list published by the Institute of Electrical and Electronics Engineers in 2017, Python is the best programming language. Arduino is the best tool to learn the hardware. Advanced mathematical knowledge is not a requirement for Arduino although it is beneficial. However, it is still a must to use the conventional microcontrollers.

A course entitled “Mathematical Physiology”, which I initiated in the fall semester of the 2017–2018 academic year, was designed to provide students with foundational knowledge of hardware through Arduino and software through Python programming. In response to student feedback and the increasing impact of artificial intelligence technologies in the field of medicine, an elective course titled “Robophysiology III: Artificial Intelligence” was introduced for the first time in 2021.

The ongoing technological transformation strongly suggests that such courses will, in the near future, become mandatory components of medical school curricula. Medicine is inevitably evolving into a domain in which humans and robots will collaborate. Therefore, institutions that aim to educate not only the physicians of today but also those of the future must take pioneering steps by incorporating courses that cover the principles of Artificial Intelligence—at least as elective offerings—into their curricula in order to adequately prepare for the future.

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Panel 2.3: The Use of Artificial Intelligence in Physiology Education and Current Developments

Oktay Kaya

Department of Physiology, Faculty of Medicine, Trakya University, Edirne, Türkiye

The incorporation of artificial intelligence (AI) into medical education—through technologies such as natural language processing (NLP), machine learning (ML), and generative pretrained transformers (GPT)—is reshaping both educational content and pedagogy. Within physiology education, these tools facilitate dynamic question generation, adaptive case-based learning, and AI-driven simulations that prepare students for complex clinical scenarios while fostering interdisciplinary collaboration. By analyzing student performance data, technological advances can identify curricular deficiencies and inform continuous educational refinement. Automation of routine instructional tasks enables educators to devote more time to meaningful engagement with students and to the clarification of complex physiological mechanisms.

Students, in turn, benefit from immediate feedback that accelerates learning and promotes rapid correction of misconceptions. However, challenges persist. Insufficient training and institutional support may hinder effective AI adoption, while disparities in access—driven by socioeconomic factors—risk widening the digital divide and deepening educational inequities. Concerns regarding data privacy and the potential for AI-generated misinformation ("hallucinations") further underscore the need for cautious implementation, particularly in disciplines as knowledge-sensitive as physiology. Excessive dependence on AI tools can diminish active learning and reduce interpersonal interaction, potentially undermining the development of critical thinking skills.

AI should be regarded as a complement to, rather than a substitute for, human educators. Its integration into physiology education represents an evolving process that demands continual evaluation, refinement, and contextual adaptation. Strategic planning at the institutional level will be essential to ensure that these emerging technologies enhance, rather than compromise, the goals of physiological education and scientific rigor.

Panel 2.4: Use of Active Learning Methods in Medical Education: An Overview and Examples

Mustafa Kemal Alimoğlu

Akdeniz University, Faculty of Medicine, Department of Medical Medical Education, Antalya, Türkiye

Active learning methods are defined as learner-centered methods in medical education literature. A learner-centered method allows students to take responsibility for their learning, plan and implement their own learning process, and the instructor takes a facilitator/guiding role while the students are more active.

Today, medical education has shifted from creating a standardized curriculum and expecting it to guide what graduates can achieve in their professional lives to defining what graduates need to achieve in their professional lives and allowing these needs to guide the program. In line with this approach, known as competency-based medical education, medical schools determine the competencies they expect from graduates and design their programs to ensure students acquire these competencies throughout their education. "Lifelong learning" is invariably among the graduate competencies determined by faculties. For graduates to develop a lifelong learning habit, they must have experiences that foster their learning responsibility, foster their curiosity, and provide opportunities for self-directed learning throughout their education. Because of their ability to provide these experiences, learner-centered educational methods must take part in educational programs. Use of such methods is a standard that must be met for the accreditation of medical education programs.

Learner-centered educational methods commonly used in medical education can be summarized as follows:
Flipped classrooms, team-based learning, conducted in large groups; Problem-based learning, scenario-based learning, escape rooms, professional skills training, conducted in small groups; Assignments, projects, reports, etc., conducted individually or in small groups.

Physiology education is vital in undergraduate medical education programs. Although it primarily takes part in the early years of the program, the outcomes of this education shape students' performance throughout their medical education and professional careers. Learner-centered methods can significantly contribute to efforts to ensure that students achieve those outcomes.

Panel 3: Clinical Practice Areas of Physiology

Panel 3.1: The Role of the Physiology Specialist in Clinical Practice from the Perspective of Exercise Physiology

Aslı Nur Bahar

Marmara University, Faculty of Medicine, Department of Physiology, Istanbul, Türkiye

Physiology constitutes the foundation of medical education and research; however, its fields of application today

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extend beyond education and experimental studies. This presentation will address the potential roles of physiology specialists in clinical settings through the example of the Exercise Physiology Outpatient Clinic at Marmara University.

The structure, workflow, patient evaluation procedures, applied tests, exercise prescription approaches, and multidisciplinary collaborations of the clinic will be presented. The presence of physiology specialists in the clinical environment contributes significantly to the accurate implementation, interpretation, and integration of physiological tests into patient management processes. This enhances the usability and clinical effectiveness of physiological assessments, leading to more reliable outcomes in patient evaluations.

During the process of clinical integration, the effects of various structural factors—such as regulatory frameworks, inter-institutional practice differences, equipment and material accessibility, ambiguities in job definitions, and the inability to schedule appointments through the national Central Physician Appointment System (MHRS)—will be discussed. Based on these experiences, the position of physiology specialists within the clinical system and the solution approaches developed throughout this process will be outline.

Panel 3.2: The Role of Physiology Specialists in Healthy Living Practices

Hilmiye Pakyürek

Uşak University, Faculty of Medicine, Department of Physiology, Uşak, Türkiye

Healthy living practices have become an area that strengthens the protective and preventive aspects of modern medicine. Today, they also make a significant contribution to the management of increasingly prevalent chronic diseases. The adoption of a healthy living culture across society requires guidance based on scientific principles. Physiology specialists can explain at a scientific level how the body's biological functions can be optimised by integrating lifestyle medicine principles and can take on the necessary guidance role in this field. This area of expertise offers the opportunity to evaluate cardiovascular health, neurophysiological functions, metabolic balance, and hormonal adaptations from a healthy living perspective. This panel will discuss the roles of physiology specialists in raising awareness of healthy living at the individual and societal levels, the development of health literacy, and areas of integration with lifestyle medicine and preventive health practices. It will also address how physiologists in multidisciplinary teams can contribute to health policies, clinical practice, and scientific research through evidence-based approaches.

Panel 3.3: From Polysomnography Laboratory to Clinic: A Field for Physiology Specialists

Enver Arslan

Trakya University, Faculty of Medicine, Department of Physiology, Edirne, Türkiye

Sleep is a fundamental biological process that profoundly impacts human health and quality of life. Polysomnography, one of the most important methods used in the diagnosis and monitoring of sleep disorders, enables the simultaneous recording of numerous physiological parameters (electroencephalography, electrooculography, jaw electromyography, thoracoabdominal movements, electrocardiography, respiratory patterns, and leg electromyography), enabling the understanding of sleep physiology and the identification of pathologies. In this context, the roles that physiology specialists can play in both research and clinical practice are becoming increasingly important. This panel will be discussed the functioning of polysomnography laboratories, the techniques used, data interpretation processes, and how the information obtained can be integrated into clinical practice. It will be also discussed how physiology specialists can play an active role in multidisciplinary teams and contribute to the diagnostic and therapeutic process. The panel aims to convey current developments in the field to physiology specialists, combining theoretical knowledge with practical area, and to encourage them to participate more actively in the diagnosis and treatment of sleep disorders. This field, situated at the intersection of sleep medicine and physiology, offers significant opportunities for physiology specialists, both academically and clinically.

Panel 3.4: Examples of Clinical Physiology Applications: Scandinavia, the United Kingdom, and the United States

Burak Kayabaşı

Gazi University, Faculty of Medicine, Department of Physiology, Ankara, Türkiye

Clinical Physiology is a diagnostic medical discipline that measures and evaluates how the body functions and how it is altered by disease, through the use of functional and imaging techniques.

When examining the development of Clinical Physiology, the earliest examples are found in Sweden. In 1940, an independent Physiology Laboratory was established at Karolinska Hospital, where Torgny Sjöstrand began his work

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as a clinical physiologist. In Sweden, ''*Clinical Physiology*'' was recognized as a medical specialty from the 1950s until 2008. In 2008, it was merged with Radiology under the title *Image and Functional Medicine*, and in 2015, ''*Clinical Physiology*'' once again became an independent specialty. The panel presents examples of the practices conducted by Clinical Physiology departments in Sweden in the areas of Cardiac Physiology, Pulmonary Physiology, Neuromuscular Physiology, Vascular Physiology, and Nuclear Imaging. In other Scandinavian countries such as Denmark and Finland, similar developments and organizational structures in the field of clinical physiology have also been observed, inspired by the Swedish model.

In England, ''*Clinical Physiology*'' is not a recognized medical specialty; however, within the National Health Service (NHS), a wide range of roles are defined under the field of *Physiological Sciences*. There are various entry pathways into programs under this field, depending on the level of the program. Individuals working in these programs can take on roles ranging from assistant positions to decision-making roles, depending on their level of education. The panel presents examples of practices in England within this *Physiological Sciences* framework, including areas such as Cardiac Sciences, Clinical Exercise Physiology, Gastrointestinal Physiology, Neurophysiology, and Respiratory and Sleep Sciences. The health systems of other countries within the United Kingdom share similar characteristics.

In the United States, Clinical Physiology-related practices are mostly integrated into other medical specialties. However, Exercise Physiology has developed a more independent professional identity. The panel also presents an example from this field.

Panel 4: Functional Roles of Neurovascular Unit Components in Neurodegenerative Diseases

Panel 4.1: Functional Roles of Neurovascular Unit Components in Neurodegenerative Diseases

Mehmet Kaya

Department of Physiology, School of Medicine, Koç University, Istanbul, Türkiye

The blood-brain barrier (BBB) consists of specialized endothelial cells lining the brain's microvasculature, which serve to separate the central nervous system from the systemic circulation and maintain neuronal homeostasis. According to the World Health Organization, arterial hypertension is a major outcome of cardiovascular disease and markedly increases the risk of cerebral ischemia and stroke. Both chronic and acute hypertension compromise BBB integrity by impairing endothelial cell function, subsequently triggering neuroinflammation, excessive oxidative stress, cognitive decline, and ultimately contributing to the onset of neurodegenerative disorders such as ischemic injury, dementia, and even Alzheimer's disease. This review aims to examine the potential consequences of hypertension-induced alterations in the permeability of barrier-forming cerebral blood microvessels, and to highlight current research efforts focused on counteracting these pathological effects.

Panel 4.2: The Roles of Social Isolation and Aging in Neuroinflammatory Processes Following Bran Injury

Ertuğrul Kılıç

Department of Physiology, School of Medicine, Medeniyet University, Istanbul, Türkiye

Social isolation is known to be associated with poor outcomes following stroke; however, the underlying mechanisms remain largely unknown. In our previous studies, we investigated the role of neuroinflammation in the context of both social isolation and aging after stroke. Our findings revealed that social isolation profoundly alters cell signaling following ischemic injury and promotes proinflammatory responses. These results highlight the importance of social support. Additionally, in our studies on aging, we evaluated the progression of ischemic damage in young and aged mice. Our findings suggest that aging may render the brain more resistant to ischemic injury, potentially through the suppression of neuroinflammation.

Panel 4.3 : Cerebral Small Vessels and Their Roles in Neurodegeneration

Yasemin Gürsoy Özdemir

Department of Neurology, School of Medicine, Koç University, Istanbul, Türkiye

The central nervous system's vascular bed differs from that of other organs due to structures such as the BBB and the perivascular space. In particular, the capillary level and the pre- and post-capillary perivascular spaces play important roles in inflammation and the response to inflammation. The involvement of cerebral small vessels and their contribution to neurodegeneration are increasingly recognized in diseases such as Alzheimer's, ALS, vascular dementia, and multiple sclerosis. In this talk, we will discuss, in light of our findings, the changes occurring in the small vessels of the central nervous system in systemic diseases such as hypertension and diabetes, as well as in neurological disorders such as ALS and multiple sclerosis, and how these changes contribute to disease pathogenesis.

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Panel 5: Thyroid Hormones and Cognitive Functions: From Molecular Mechanisms to Electrophysiological Assessment

Panel 5.1: Electrophysiological Markers of Thyroid-Induced Cognitive Impairment

Prof. Dr. Nazan Dolu

Istanbul Medipol University, Faculty of Medicine, Department of Physiology, Istanbul

Thyroid hormones have important effects on central nervous system development, synaptic plasticity, and neurotransmitter balance. Changes in thyroid hormone levels can lead to cognitive impairments in hypothyroid, hyperthyroid, and even euthyroid states. Identifying cognitive deficits due to thyroid dysfunction is critical for early diagnosis and treatment. Electrophysiological measurements offer the potential for earlier and more objective assessment compared to traditional neuropsychological tests. This section examines the electrophysiological markers used to assess cognitive functions in thyroid diseases, including electrodermal activity measurements (EDA) and event-related potentials (ERP). Electrodermal activity reflects the activity of the eccrine sweat glands, which are innervated by sympathetic nerves, and is frequently used in the assessment of attention levels and cognitive activity. EDA has been found to exhibit changes in both hyperthyroid and hypothyroid patients. Event-related potentials, one of the most commonly used methods for assessing cognitive functions in thyroid patients, are auditory evoked potentials (AEPs), which are produced by stimulating the brain's electrical activity with auditory stimuli, or visual evoked potentials (VEPs), which are produced by stimulating it with visual stimuli. The most frequently evaluated parameter in AEPs is the measurement of the amplitude and latency of the positive wave (P300), which occurs 300 milliseconds after the auditory stimulus. In particular, prolonged P300 latency and decreased amplitude reflect impairment in attention and working memory functions. Decreased cognitive function in both hyperthyroid and hypothyroid patients is demonstrated by P300 wave changes. Electrophysiological studies have also supported the partial normalization of these changes after levothyroxine replacement therapy.

These methods are considered promising approaches for detecting changes in cognitive function even before clinical symptoms become apparent, suggesting that they may be promising biomarkers for the early detection of thyroid-related cognitive effects.

Panel 5.2: The Molecular Basis for the Neuroprotective Effects of Thyroid Hormones

Ali Yücel Kara

İzmir Kâtip Çelebi University, Faculty of Medicine, Department of Physiology, İzmir

Thyroid hormones play a critical role in maintaining neuronal integrity in the central nervous system and in recovery after brain injury. T3 treatment has been shown to prevent apoptosis, protect mitochondrial function, stimulate neurogenesis, and accelerate functional recovery in animal models.

The molecular mechanisms underlying these neuroprotective effects are multifaceted. T3 controls cellular adaptation through epigenetic regulation. In cortical neurons exposed to hypoxia, it decreases DNA methyltransferase (DNMT) 3a and 3b levels and increases the expression of ten-eleven translocation (TET) enzymes. These changes lead to the activation of survival genes such as hypoxia-inducible factor 2 alpha (HIF-2α), vascular endothelial growth factor (VEGF), and Kruppel-like factor 9 (KLF9). T3 also plays an important role in the regulation of mitochondrial bioenergetics. It enhances mitochondrial biogenesis by stimulating the expression of peroxisome proliferator-activated receptor gamma coactivator 1 alpha (PGC-1α) and nuclear respiratory factor 1 (NRF1). It also supports mitochondrial energy production by increasing the expression of fatty acid oxidation enzymes such as carnitine palmitoyltransferase-1 (CPT1). These mechanisms are crucial in hypoxic brain injury. Through non-genomic pathways, T3 induces rapid neuroprotective responses. It increases the expression of anti-apoptotic proteins by activating phosphatidylinositol 3-kinase (PI3K) and protein kinase B/AKT signaling pathways. In acute neurological events such as traumatic brain injury (TBI) and stroke, decreased thyroid hormone levels are associated with a poor prognosis. Clinical studies have shown that patients with low triiodothyronine (T3) levels have a significantly higher mortality rate.

Elucidating the molecular mechanisms underlying the neuroprotective effects of thyroid hormones will contribute to the development of innovative treatment strategies in acute neurological injury and neurodegenerative diseases. Findings from animal models demonstrate the potential of thyroid hormone therapy to promote neuronal recovery after injury. Further research will enable the validation of these therapeutic approaches in clinical trials and their integration into translational medicine.

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Panel 5.3: Cognitive effects of thyroid dysfunction

Ankara Medipol University, Faculty of Medicine, Department of Physiology, Ankara, Türkiye

Thyroid hormones are fundamental regulators of brain development and the maintenance of neurocognitive abilities in adulthood. They influence attention, memory, and executive functions by modulating neuronal differentiation, myelination, and synaptic transmission. Recent research has demonstrated that even minor alterations in thyroid hormone levels can result in substantial changes in cognitive performance.

Both hypothyroidism and hyperthyroidism cause deficits in attention, processing speed, and working memory; however, the underlying mechanisms differ. In hypothyroidism, decreased levels of thyroxine (T4) and triiodothyronine (T3) result in reduced glucose metabolism and cerebral perfusion in the hippocampus and prefrontal cortex, leading to slower information processing and impaired memory consolidation. These changes are often accompanied by fatigue and depressive symptoms. In elderly adults, mild deficits in executive functioning have been observed even in subclinical hypothyroidism.

Hyperthyroidism, on the other hand, induces increased adrenergic activity and oxidative stress, resulting in hyperexcitability, anxiety, and concentration difficulties. Functional MRI studies have demonstrated connectivity abnormalities in frontoparietal and limbic networks during the hypermetabolic phase, followed by normalization after treatment. While cognitive symptoms often improve once euthyroid status is achieved, small persistent deficits in attention and executive functions may remain.

In conclusion, thyroid hormones significantly affect attention, memory, and executive functions through metabolic, vascular, and neuronal pathways. Therefore, routine cognitive assessments are important in the clinical follow-up of individuals with thyroid dysfunction.

Panel 6: Artificial Intelligence in Academia: From Fundamentals to Ethical and Practical Implications

Panel 6.1: Algorithmic Consciousness and Neo-Luddism: The Historical Debate and Current Medical Applications of Artificial Intelligence

Tunahan Anber

Pamukkale University, Faculty of Medicine, Department of Physiology, Denizli, Türkiye

The fundamental question, “Can a machine think?”, first posed in the seminal work of Alan Turing, the founder of modern computer science, in the 1950s, is currently being reshaped by the concept of neo-Luddism, which reflects contemporary anxieties regarding technological development. In this context, Luddism, defined by the organized actions of 19th-century English textile workers who smashed labor-saving machinery out of fear that these new technologies would take away their jobs, has transformed into professional and existential concerns about today's Artificial Intelligence (AI) systems. Contributing to this historical debate, Turkish mathematician Ord. Prof. Dr. Cahit Arf argued in 1959 that machines "cannot process aesthetic elements" and, due to the inherent element of uncertainty in these qualities, they "cannot comply with infallible rules.". This perspective added a philosophical dimension to the ongoing discussion about the limits of AI’s cognitive capacity. Although AI systems have not yet achieved the self-awareness and general intelligence Arf spoke of, they are making tangible and measurable progress in medicine, particularly through Limited Memory AI types (which learn from past data) and Generative AI applications.

AI is widely used in many areas of our lives. When examining the overall use of AI for all purposes, more than 10% of users employ these tools for academic tasks. In academia, one of the most frequently utilized corporate functions of AI is scientific literature review and research analysis. The number of published articles on Large Language Models (LLMs) in the PubMed database alone exceeded 1.200 in 2024 (1210). AI usage is also increasing in the clinical field, with the number of clinical trials involving AI rising steadily from 2014–2024, reaching 537 in 2024. Furthermore, the number of AI-based/supported medical devices approved by the U.S. Food and Drug Administration (FDA) rose to 129 in 2023. AI’s transformative power is also evident in biomedical research. In one experiment, an AI-based laboratory, managed by human researchers, was tasked with designing antibody fragments (nanobodies) that could bind to the virus causing SARS-CoV-2. This laboratory produced 92 antibodies and achieved a success rate of over 90% (successful binding to the virus) in verification studies. All this potential underscores the necessity of gaining AI Literacy and the obligation to always verify the outputs within the framework of algorithmic consciousness, given AI's tendency to produce false or incorrect information, which is termed "hallucination."

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Panel 6.2: From the Evolution of the Scientific Method to the Age of Artificial Intelligence: Generative AI Tools and Ethical Responsibilities in Physiological Research

Hasan Akça

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The 2,500-year history of science shows that methods may change, but the purpose remains the same: to pursue an honest understanding of nature. From the observational medicine of Hippocrates and Galen to Claude Bernard's experimental physiology, from the simulation models of Hodgkin and Huxley to the data-driven approach of the Human Genome Project, the scientific method has continuously evolved. In the twenty-first century, this evolution has entered a new phase with the integration of generative artificial intelligence (AI) systems.

Today, at every stage of physiological research—including literature review, hypothesis generation, experimental design, data analysis, and scientific writing—tools such as ChatGPT, Gemini, Consensus, ResearchRabbit, Elicit, GitMind, Connected Papers, Scite, and PaperPal offer researchers unprecedented speed and accessibility. However, the convenience provided by these tools also introduces new ethical responsibilities.

This panel will discuss, within the framework of ethical guidelines issued by the Council of Higher Education (YÖK), the Scientific and Technological Research Council of Türkiye (TÜBİTAK), the European Commission (EC), and the U.S. National Institutes of Health (NIH), the principles governing the ethical use of generative AI tools in different stages of scientific research. Across these guidelines, five core principles emerge: accuracy in literature review, maintaining the primacy of human judgment in forming hypotheses and interpreting findings, transparency in experimental design, accountability in data analysis, and integrity in scientific writing.

The aim is to critically evaluate the potential of generative AI within physiological research and to explore how the core values of the scientific method (truthfulness, transparency, and human responsibility) can be preserved in the data-driven era.

Panel 6.3: *In Silico* Approaches with Artificial Intelligence Applications in Molecular Physiology

Arif Kamil Salihoğlu

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Molecular physiology is an interdisciplinary discipline that seeks to elucidate the dynamic behavior of biomolecules underlying cellular functions. In recent years, *in silico* approaches and related artificial intelligence (AI)–assisted analytical methods have become powerful tools that complement experimental workflows in this discipline. The application of AI algorithms in protein structure prediction, receptor–ligand interaction studies, gene expression profiling, metabolic network modeling, and systems biology analyses enables a comprehensive understanding of molecular and cellular mechanisms. Deep learning models facilitate the extraction of functional relationships from high-dimensional datasets, while natural language processing-based bioinformatics tools contribute significantly to literature mining and the optimization of experimental design. These advances assist in predicting molecular interactions and pathophysiological processes that are often inaccessible through classical experimental approaches.

In molecular modeling and structural visualization, software such as Avogadro, UCSF Chimera, and PyMOL is widely used. Protein structure prediction commonly employs AlphaFold2 and RoseTTAFold; ligand–receptor interaction analyses utilize AutoDock Vina, GOLD, and Glide; and molecular dynamics simulations are performed using GROMACS, AMBER, and NAMD. QSAR modeling and machine learning–based *in silico* studies are carried out with PaDEL-Descriptor, KNIME, WEKA, and PyCharm, along with Python-based deep learning frameworks. For multi-omics integration and network biology, tools such as Cytoscape, OmicsNet 2.0, and mixOmics are widely applied, while functional enrichment analyses often rely on Gene Set Enrichment Analysis (GSEA), Gene Ontology (GO), and Enrichr. In large-scale data analyses, GEO2R and SRA Run Selector provide essential resources for the statistical evaluation of transcriptomic and sequencing data.

The execution of these *in silico* workflows on cloud-based platforms such as Google Colab, through command-line or Python-integrated environments, enhances computational accessibility and reproducibility. The fundamental principles, applications, and methodological limitations of *in silico* modeling, machine learning, deep learning, and multi-omics integration are examined in the context of the innovative scientific perspectives offered by these computational approaches to neurophysiology, metabolism, and cellular signaling. These AI-assisted computational methodologies represent a transformative paradigm for elucidating molecular mechanisms of physiological processes, identifying novel therapeutic targets, and supporting translational research by reducing the reliance on extensive *in vitro* and *in vivo* experimentation.

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Panel 7: Electrooculography: Physiological Mechanisms and Diagnostic Perspectives in Dynamic and Sensory Recording Paradigms

Panel 7.1: Sensory Electrooculogram (EOG): Physiological Basis and Clinical Significance

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The sensory electrooculogram (EOG) is an electrophysiological test that measures the functional activity of the retinal pigment epithelium (RPE). As the only method capable of assessing the physiological interaction between photoreceptors and the RPE, EOG provides unique information about outer retinal function. The test is based on the transepithelial potential generated by chloride and potassium ion channel activity in the RPE's basolateral membrane during light adaptation. This potential change is recorded as a biphasic waveform—dark trough and light peak—and quantified using the Arden ratio. In normal subjects, the Arden ratio ranges between 180–250%, while values below 150% are considered pathological.

During the test, electrodes are placed at both lateral canthi, and the subject is asked to follow a moving light target. Separate recordings are made during dark and light adaptation phases. The resulting waveform reflects RPE ion transport function and metabolic integrity. EOG has substantial diagnostic and follow-up value in diseases such as Best vitelliform macular dystrophy, retinitis pigmentosa, toxic retinopathies, and diabetic retinopathy.

In conclusion, the sensory EOG is a reliable electrophysiological method that directly evaluates RPE function and complements ERG and VEP testing. It is particularly valuable for early detection in disorders where photoreceptors remain intact but RPE function is impaired.
This panel was organized within the scope of the TÜBİTAK 1004 Center of Excellence Support Program titled "Development of Biomarkers and Advanced Technological Stimulation Systems for the Diagnosis, Monitoring, and Treatment of Neuron Damage–Related Diseases." It was conducted under Project-4, "Enhancement of the Effectiveness and Precision of Electroneurophysiological Systems in the Diagnosis of Neuron Damage–Related Diseases," coordinated by the Istanbul University-Cerrahpaşa Clinical Research Excellence Application and Research Center (IU-C KAMM).

Panel 7.2: Dynamic Electrooculography (EOG): Electrophysiological Evaluation of Visual–Vestibular Integration

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Electrooculography (EOG) is a noninvasive method based on recording the potential difference between the cornea and the retina to measure changes in the electrical axis of the eyeball. Dynamic EOG, unlike conventional sensory EOG, analyzes the time-varying components of eye movements, thereby revealing the dynamic physiology of the oculomotor system. During saccadic, pursuit, and vestibulo-ocular reflex (VOR) movements, potential changes are recorded with high temporal resolution, allowing functional assessment at both central and peripheral levels.

Dynamic EOG serves as an important tool for evaluating the integration between the visual and vestibular systems. This method enables objective analysis of ocular responses to changes in visual attention, rapidly shifting visual stimuli, and alterations in head position. By assessing the interaction between the brainstem, cerebellum, and vestibular nuclei, it allows electrophysiological evaluation of the integrity of central balance networks.

Clinically, Dynamic EOG provides valuable information in the differential diagnosis of various types of nystagmus, in measuring visual compensation capacity in vestibular neuritis and Ménière's disease, and in analyzing saccadic velocity and latency in neurological disorders such as multiple sclerosis, Parkinson's disease, and cerebellar degeneration. It is also useful in assessing oculomotor apraxia, internuclear ophthalmoplegia, and congenital nystagmus. Furthermore, Dynamic EOG aids in distinguishing central and peripheral components of balance disorders, determining the electrophysiological correlates of visual attention, and monitoring rehabilitation processes. With its integrative perspective bridging ophthalmology and neurology, Dynamic EOG is emerging as a contemporary electrophysiological method for investigating the physiological foundations and pathological deviations of visual–vestibular integration.

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Panel 7.3: Electrophysiological and Ionic Basis of Sensory and Dynamic Electrooculography (EOG)

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Electrooculography (EOG) is an electronurophysiological method used to record the electrical potential difference between the retina and the retinal pigment epithelium (RPE). The eye behaves as a biological dipole, with the cornea being electropositive and the retina electronegative. This corneoretinal potential originates primarily from ionic transport across the RPE, especially through the movement of K^+, Na^+, and Cl^- ions via active and passive mechanisms. The asymmetric distribution of these ion channels between the apical and basolateral membranes of RPE cells forms the basis of the standing electrical potential of the eye.

The sensory EOG records slow, steady-state (DC) variations in this potential. During light and dark conditions, the ionic conductance of the RPE changes dynamically: K^+ conductance increases, Cl^- channels are activated, and Na^+/K^+-ATPase activity is enhanced. These ionic fluctuations modulate the trans-epithelial potential of the RPE and represent the electrophysiological outcome of ion exchange between photoreceptors and RPE cells. Sensory EOG reflects the overall ionic balance and membrane conductance dynamics as a slow electrical potential recorded from the ocular surface.

The dynamic EOG, in contrast, measures rapid (AC) transient potential changes that occur during eye movements. As the corneoretinal dipole rotates, short-lived shifts in Na^+ and Cl^- fluxes and transient increases in subretinal K^+ concentration occur. These ionic redistributions coincide with oculomotor commands and generate brief voltage fluctuations measurable on the skin electrodes. Thus, dynamic EOG captures both the bioelectrical activity associated with extraocular muscle movement and the transient ionic responses at the RPE–retina interface.

In conclusion, sensory EOG reflects the temporal dynamics of RPE ionic homeostasis and membrane conductance, while dynamic EOG represents the rapid ion fluxes synchronized with ocular motion. Together, these complementary approaches provide a comprehensive electronurophysiological understanding of ionic regulation within the visual system and the neural control of oculomotor activity.

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