Gap Junctions In The Nervous System Neuroscience Intelligence Unit

Given that the extremely elaborated and dynamic functions performed by the nervous system require the close synchronization of brain cells, complex organisms have developed different mechanisms of intercellular communication. At this regard, paracrine signaling between neighboring cells is currently recognized as one of the most widely distributed mechanisms of synchronization in the brain parenchyma. In mammals, paracrine signaling is in part mediated by single membrane channels formed by connexins (connexons/hemichannels) or pannexins (pannexons), which are two different membrane protein families composed of about 20 and 3 members, respectively. Single membrane channels formed by these proteins serve as aqueous pores permeable to ions and small molecules, allowing the diffusional exchange between the intra- and extracellular milieu. Thus, connexin hemichannels and pannexons permit the release of significant quantities of autocrine/paracrine signaling molecules (e.g., ATP, glutamate, NAD+, adenosine and PGE2) into the extracellular milieu, as well as the uptake of small molecules. An increasing body of evidence has revealed that connexin hemichannels and pannexons play a crucial role in a plethora of brain processes including blood flow regulation, Ca2+ wave propagation, memory consolidation, glucose sensing and cell migration and adhesion. Considering the multiple cell signaling functions of these channels, their dysregulation is proposed not only as potential pathological biomarker, but it has been implicated in the pathogenesis and progression of diverse brain diseases (e.g., meningitis, Alzheimer's disease and stroke). The aim of this Research Topic is to gather a collection of original research articles, method, protocols, short communications, opinions, perspectives, as well as review articles, providing the latest progress and insights in the field of connexin hemichannels and pannexons in the nervous system. Within this volume we plan to cover from basic research including channel structure, regulation, pharmacology and trafficking; to different biological functions in the physiology (behavior, plasticity, neurogenesis, blood flow control, neuron-glia crosstalk, cell migration and differentiation) as well as in the pathophysiology (neuroinflammation, mutation-related diseases, glial dysfunction and neurodegeneration) of the nervous system. We hope that this collection of articles will serve to understand how the signaling of connexin hemichannels and pannexons influences both normal and pathological brain function.

Intercellular communication is part of a complex system of communication that governs basic cellular activities and coordinates cell actions. The ability of cells to perceive and correctly respond to their environment is the basis of growth and development, tissue repair, and immunity as well as normal tissue homeostasis. Errors in cellular information processing are responsible for diseases such as cancer, autoimmunity, diabetes, and neurological and psychiatric disorders. There is substantial drug development concentrating on this and intercellular communication is the basis of much of neuropharmacology. By understanding cell signaling, diseases may be treated effectively and, theoretically, artificial tissues may be yielded. Neurotransmitters/receptors, synaptic structure and organization, gap junctions, neurotrophic factors and neuropeptides are all explored in this volume, as are the ways in which signaling controls neuroendocrinology, neuroimmunology and neuropharmacology. Intercellular Communication in the Nervous System provides a valuable desk reference for all scientists who consider signaling. * Chapters offer impressive scope with topics addressing neurotransmitters/receptors, synaptic structure and organization, neuropeptides, gap junctions, neuropharmacology and more * Richly illustrated in full color with over 200 figures * Contributors represent the most outstanding scholarship in the field, with each chapter providing fully vetted and reliable expert knowledge

Astrocytes were the original neuroglia that Ramón y Cajal visualized in 1913 using a gold sublimate stain. This stain targeted intermediate filaments that we now know consist mainly of glial fibrillary acidic protein, a protein used today as an astrocytic marker. Cajal described the morphological diversity of these cells with some ast- cytes surrounding neurons, while the others are intimately associated with vasculature. We start the book by discussing the heterogeneity of astrocytes using contemporary tools and by calling into question the assumption by classical neuroscience that neurons and glia are derived from distinct pools of progenitor cells. Astrocytes have long been neglected as active participants in intercellular communication and information processing in the central nervous system, in part due to their lack of electrical excitability. The follow up chapters review the "nuts and bolts" of ast- cytic physiology; astrocytes possess a diverse assortment of ion channels, neu- transmitter receptors, and transport mechanisms that enable the astrocytes to respond to many of the same signals that act on neurons. Since astrocytes can detect chemical transmitters that are released from neurons and can release their own extracellular signals there is an increasing awareness that they play physiological roles in regulating neuronal activity and synaptic transmission. In addition to these physiological roles, it is becoming increasingly recognized that astrocytes play critical roles during pathophysiological states of the nervous system; these states include gliomas, Alexander disease, and epilepsy to mention a few.

Molecular Biology of the Cell

Gap Junctions

A Study with Freeze-etch Technique

The Relationship Between Gap Junctional Intercellular Communication and Differentiation in a Human Fetal Cell Line Isolated from the Central Nervous System

Intercellular Communication in the Nervous System

The objective of this project was to determine the functional states of astrocytic gap junctions under physiological and pathological conditions by analyzing the expression, localization, phosphorylation and immunorecognition of a major astrocytic gap junction protein, connexin43 (Cx43). These studies were aided by antibody 13-8300 that selectively recognizes the non-phosphorylated form, but not the multiply phosphorylated forms of Cx43 in several cell types in vitro and in vivo. The failure of 13-8300 to recognize phosphorylated Cx43 is likely due to blockade of phosphate groups, suggesting that the epitope recognized by 13-8300 contains an early phosphorylation site. Non-phosphorylated Cx43 was seen primarily in he cytoplasm, whereas phosphorylated Cx43 was seen at gap junctions as well as in the cytoplasm. Sciatic nerve stimulation induced preferential dephosphorylation of junctional Cx43 in spinal cord astrocytes, suggesting that junctional Cx43 is more vulnerable to dephosphorylation than cytoplasmic Cx43 and that astrocytic gap junctional intercellular communication (GJIC) can be regulated by neuronal activity. Dephosphorylation of astrocytic Cx43 was also seen in ischemic rat brain. Thus, Cx43 dephosphorylation may represent a common mechanism of the regulation of astrocytic GJIC under physiological and pathological conditions. Mild brain ischemia induced rapid and reversible Cx43 dephosphorylation, whereas severe ischemia led to total removal of Cx43 gap junctions in the lesion center surrounded by a zone of dephosphorylated Cx43 in the penumbral region, indicating distinct functional states of astrocytes in these regions. Reactive astrocytes appear in injured rat CNS at a later survival time and in the vicinity of senile and amyloid plaques in human Alzheimer's disease brain. These cells may express Cx43 and form gap junctions, indicating the re-establishment of GJIC in damaged tissue. Chemical hypoxia induced immediate reduction of astrocytic GJIC in vitro.

This book deals with the types of gap junction proteins (connexins) and their distribution within the nervous system, the physiological properties of channels formed of each connexin, and the role of gap junction channels in functions of normal and pathological brain and peripheral nerve. Although glial tissue is emphasized, additional groups of chapters deal with neurons in the central nervous system and with the retina.

Gap junctions are present in nearly all tissues, regardless of their embronic origin and have long been of great interest to scientists from many different disciplines. The international meeting on which this book is based brought together 157 scientists from 12 countries and almost as many scientific disciplines. The papers presented at the meeting were reviewed and updated prior to publication in this book. The seven parts of the book progress from general topics to the more specific ones (role of gap junctions in various tissues, regulation and biochemistry, and cancer).

Expression of the Neuronal Gap Junction Protein, Connexin 35, in Zebrafish Central Nervous System Following Peripheral Nerve Injury

Dialogue between Glia and Neurons

Sensory Processes

Role of Fast-spiking Interneurons in Striatum

Anatomy & Physiology

Thirty-five years ago, when Stephen Kuffler and his colleagues at Harvard initiated a new era of research on the properties and functions of neuroglial cells, very few neuro scientists were impressed at the time with the hypothesis that neuroglial cells could have another, though more subtle, role to play in the nervous system than to provide static support to neurons. Today, very few neuroscientists are unaware of the fact that multiple interactions between neurons and glial cells have been described, and that they consti tute the basis for understanding the function and the pathology of the nervous system. Glial cells outnumber neurons and make up about one-half of the bulk of the nervous system. They are divided into two major classes: first, the macroglia, which include astrocytes and oligodendrocytes in the central nervous system, and the Schwann cells in the peripheral nervous system; and second, the microglial cells. These different classes of glial cells have different functions and contribute in different ways in the devel opment, function, and the pathology of the nervous system.

This core text emphasizes the underlying neural structures and functions of sensory systems (pain, olfaction, gustation, audition, vision, etc.) and presents this complex material at a level comprehensible to undergraduates as well as beginning graduate students. The text begins with a review of the central nervous system and its sensory components and includes discussions of methodological techniques and procedures used to study sensory processes.

Plasma membrane-associated channels known as gap junctions, along with their protein building blocks—connexins—have an important functional role in a range of immunological processes, including heart function, cell growth and specialization, and early development. Spanning basic science and potential clinical applications, Connexin Cell Communication Channels: Roles in the Immune System and Immunopathology assembles and synthesizes four decades of the most important research carried out in this field. The book first provides a historical overview of the discovery of these membrane channels in cells and tissues of the immune system. It describes their general molecular and biological characteristics and examines how they participate in the evolution, organization, function, and regulation of leukocytes, as well as their interaction with other tissues. The next section examines immunologically related disease scenarios where gap junctions and connexins have been shown to play a fundamental role. The contributors explain how gap junctional communication participates in the establishment and maintenance of immunological properties such as antibody and cytokine production, as well as lymphocyte immune surveillance in both physiological and pathological conditions. The book explores the most important technical approaches used and how they have been specially adapted to answer key biological questions particular to the mobile nature of leukocytes. It also describes the most recent understanding of how gap junctions and connexins participate in antigen recognition, cross-presentation, lymphocyte activation, and in the assembly and function of the immunological synapse. Finally, the book focuses on the latest progress made on translating the knowledge gained to specific treatment modalities. Topics in this section include approaches for reducing scarring and cardiac arrhythmia, combating inflammation in the central nervous system, and enhancing epithelial tissue repair. A comprehensive view of achievements in this promising field, the book will inform and update specialists, clinical practitioners, and those studying the potential for commercial applications.

Intercellular Communication through Gap Junctions

Rio de Janeiro, RJ, Brazil - June 6-11, 1998

The Role of Gap Junctional Coupling in Motor Neuron and Neuromuscular Junction Development

The Functional Roles of Glial Cells in Health and Disease

Roles in the Immune System and Immunopathology

Gap junctions between glial cells or neurons are ubiquitously expressed in the mammalian brain and play a role in brain development including cell differentiation, cell migration and survival, and tissue homeostasis, as well as in human diseases including hearing loss, neuropathies, epilepsy, brain trauma, and cardiovascular disease. This volume provides neuroscience researchers and students with a single source for information covering the physiological, behavioral and pathophysiological roles of gap junctions in the brain. In addition, the book also discusses human disease conditions associated with mutations in single gap junction connexion genes, making it applicable to clinicians doing translational research. Finally, it includes reviews of pharmacological studies with gap junction blockers and openers, summarizing information obtained from phenotyping gap junctions mouse mutants. Serves as the most current and comprehensive reference available covering the physiological, behavioral and pathophysiological roles of gap junctions in the brain Chapters summarize knowledge of the basic physiology of gap junctions in the brain, as well as of human disease conditions associated with mutations in single gap junction connexin genes Includes reviews of pharmacological studies with gap junction blockers and openers, summarizing information obtained from phenotyping gap junctions mouse mutants

*he biological sciences are dominated by the idea that cells are the functionally autonomous, physically separated, discrete units of life. TThis concept was propounded in the 19th century by discoveries of the cellular structuring of both plants and animals. Moreover, the ap parent autonomy of unicellular eukaryotes, as well as the cellular basis of the mammalian brain (an organ whose anatomy for a long while defied attempts to validate the idea of the cellular nature of its neurons), seemed to provide the final conclusive evidence for the completeness of *cell theory', a theory which has persisted in an almost dogmatic form up to the present day. However, it is very obvious that there are numerous observations which indicate that it is not the cells which serve as the basic units of biological life but that this property falls to some other, subcellular assemblage. To deal with this intricate problem concerning the fundamental unit of living matter, we proposed the so-called Cell Body concept which, in fact, devel ops an exceedingly original idea proposed by Julius Sachs at the end of the 19th century. In the case of eukaryotic cells, DNA-enriched nuclei are intimately associated with a microtubular cytoskeleton. In this configuration—as a Cell Body—these two items comprise the fundamental functional and struc tural unit of eukaryotic living matter. The Cell Body seems to be inherent to all cells in all organisms.*

This is a thorough revision of the standard text on local circuits in the different regions of the brain. In this fifth edition, the results of the mouse and human genome projects are incorporated for the first time. Also for the first time, the reader is oriented to supporting neuroscience databases. Among the new advances covered are 2-photon confocal laser microscopy of dendrites and dendritic spines, biochemical analyses, and dual patch and multielectrode recordings, applied together with an increasing range of behavioral and gene-targeting methods.

Gap Junction's Effects in the Central Nervous System

Cell and Molecular Biology

The Neuron

Physiological and Pathological Roles

Evolution of the First Nervous Systems

AY's Neuroanatomy of C. elegans for Computation provides the neural circuitry database of the nematode Caenorhabditis elegans, both in printed form and in ASCII files on 5.25-inch diskettes (for use on IBM® and compatible personal computers, Macintosh® computers, and higher level machines). Tables of connections among neuron classes, synapses among individual neurons, gap junctions among neurons, worm cells and their embryonic origin, and synthetically derived neuromuscular connections are presented together with the references from which the data were compiled and edited. Sample data files and source codes of FORTRAN and BASIC programs are provided to illustrate the use of mathematical tools for any researcher or student interested in examining a natural neural network and discovering what makes it tick.

The nematode C. elegans is one of the most important model organisms for understanding neurobiology. Its completely mapped neural connectome of 302 neurons and fully characterized and stereotyped development have made it a prototype for understanding nervous system structure, development, and function. Fifty-six out of C. elegans' total of 959 somatic cells are classified as neuroglia. Although research on worm glia has lagged behind studies focused on neurons, there has been a steep upswing in interest during the past decade. Information arising from the recent burst of research on worm glia supports the idea that C. elegans will continue to be an important animal model for understanding glial cell biology. Since the developmental lineage of all cells was mapped, each glial cell in C. elegans is known by a specific name and has research associated with it. We list and describe the glia of the hermaphrodite form of C. elegans and summarize research findings relating to each glial cell. We hope this lecture provides an informative overview of worm glia to accompany the excellent and freely available online resources available to the worm research community.

Membrane Morphology of the Vertebrate Nervous System

Structure and Function of the Developing and Mature Astrocyte Syncytium in the Brain

Gap Junctions in the Nervous System

Single Membrane Channels Formed by Connexins or Pannexins: Focus on the Nervous System

Gap Junctions in the Brain

Gap Junctions in the Nervous and Cardiovascular Systems: Clinical Implications

Epilepsy is a devastating group of neurological disorders characterized by periodic and unpredictable seizure activity in the brain. There is a critical need for new drugs and approaches given than at least one-third of all epilepsy patients are not made free of seizures by existing medications and become "medically refractory". Much of epilepsy research has focused on neuronal therapeutic targets, but current antiepileptic drugs often cause severe cognitive, developmental, and behavioral side effects. Recent findings indicate a critical contribution of astrocytes, star-shaped glial cells in the brain, to neuronal and network excitability and seizure activity. Furthermore, many important cellular and molecular changes occur in astrocytes in epileptic tissue in both humans and animal models of epilepsy. The goal of Astrocytes and Epilepsy is to comprehensively review exciting findings linking changes in astrocytes to functional changes responsible for epilepsy for the first time in book format. These insights into astrocyte contribution to seizure susceptibility indicate that astrocytes may represent an important new therapeutic target in the control of epilepsy. Astrocytes and Epilepsy includes background explanatory text on astrocyte morphology and physiology, epilepsy models and syndromes, and evidence from both human tissue studies and animal models linking functional changes in astrocytes to epilepsy. Beautifully labelled diagrams are presented and relevant figures from the literature are reproduced to elucidate key findings and concepts in this rapidly emerging field. Astrocytes and Epilepsy is written for neuroscientists, epilepsy researchers, astrocyte investigators as well as neurologists and other specialists caring for patients with epilepsy. Presents the first comprehensive book to synthesize historical and recent research on astrocytes and epilepsy into one coherent volume Provides a great resource on the field of astrocyte biology and astrocyte-neuron interactions Details potential therapeutic targets, including chapters on gap junctions, water and potassium channels, glutamate and adenosine metabolism, and inflammation

Astrocytes establish the largest syncytial network in the central nervous system through extensive gap junctional coupling. This prominent network is functionally crucial in normal brain physiology as genetic deletion of astrocytic gap junctions results in massive neurological deficits, including dysregulated K+ and glutamate concentrations, interrupted synaptic transmission, and impaired sensorimotor/spatial memory tasks. Surprisingly, the basic physiological properties of individual astrocytes remain intact in gap junction-null mice. This strongly indicates that dysfunction of the syncytium, rather than dysfunction of individual astrocytes, initiates the devastating neurological dysfunction observed among these mice. Therefore, syncytial coupling appears to be necessary and crucial for astrocyte function in the brain. Gap junctions are a cluster of channels that connect cells to mediate the exchange of ions and small molecules smaller than 1.2 kDa. In addition, gap junctions enable electrical coupling to synchronize electrical activity. For example, at the time that neuronal gap junctions were discovered, the electrical role of this coupling was immediately determined to be electrical synapses that propagate action potentials among coupled neurons. On the contrary, astrocytes are non-excitable glial cells. Consequently, the electrical role of astrocyte syncytial coupling remained a mystery for over 50 years until 2016. Specifically, the study from our laboratory shows that a strong electrical coupling enables hippocampal astrocytes to constantly equalize their membrane potentials so that a syncytial isopotentiality can be achieved. The existence of syncytial isopotentiality is evidently shown from the following observation. The physiological resting membrane potential of a syncytial-coupled astrocyte can be readily dissipated through a non-physiological K+-free/Na+ electrode solution. However, the neighboring astrocytes are able to collectively compensate for the loss of membrane potential to a quasi-

physiological level. This newly discovered mechanism could be essential in maintaining homeostatic extracellular ionic and neurotransmitter concentrations. In Chapter 2 of this dissertation, we extended the foundational observations in the hippocampus to other regions in the central nervous system. We demonstrate that astrocyte syncytial isopotentiality is a system-wide electrical feature across the brain and spinal cord, and syncytial coupling strength varies in different brain regions. We also show that from an electrical standpoint, the astrocyte syncytium behaves as a single cytoplasmic network. Our novel method to monitor syncytial coupling led us to examine when the astrocyte syncytium reaches full coupling strength during development.

A Cytoplasm Connexon or Hemichannel Cytoplasm external loop I - P. M. N-Termlnus Fig. 1. 1. Topology of gap junction channels. (A) Cap junction channels, extending from the cytoplasm of one cell to the cytoplasm of another, are formed by two connexons or hemichannels connected across extracellular space. (B) Each connexon is formed from six connexin subunits, each having four membrane-spanning domains and both amino and carboxyl termini within the cytoplasm. External/oops (I and II} are believed to provide the high affinity interactions between the hemichannels. 4 Gap }unctions in the Nervous System P-region of voltage sensitive nonjunctional molecules; these contributed disulfide 9 channels. And Delmar's group has ob bridges are presumably involved in intra tained evidence that intracellular acidifi connexin and inter-EL loop tertiary struc cation may result in a conformational ture. An old observation that should be change analogous to the ball and chain repeated stoichiometrically with modern techniques is that gap junction channels model of inactivation of voltage gated ionic can be split into connexons or hemi channels, whereby the carboxyl terminal channels using hyperosmotic disaccharide portion of connexin43 binds to CL, closing 23 solutions again implying that linkage is the channel. Higher order structure of the channel not covalent. is believed to consist of six connexins form ing the hemichannel or connexon in a 3.

Workshop Held in Rio de Janeiro on 6-11 June, 1998 on "Gap Junctions in the Nervous and Cardiovascular Systems: Clinical Implications"

Cell-Cell Channels

Immunohistochemical Analysis of Gap Junction Protein Connexin43 Following Retinal Ischaemia and in the Normal and Diseased Human Eye

Modulation of Central Nervous System Gap Junctions [microform]

Membrane Morphology of the Vertebrate Nervous System

Gap Junctions in the Nervous SystemSpringer

Plasma membrane-associated channels known as gap junctions, along with their protein building blocks-connexins-have an important functional role in a range of immunological processes, including heart function, cell growth and specialization, and early development. Spanning basic science and potential clinical applications, Connexin Cell Communicati

Research on intercellular communication through gap junctions has continued to expand, and the meeting on which this book is based brought together many scientists from many different countries and disciplines. In line with the objective of the meeting, this volume focuses on the biological meaning of intercellular communication through gap junctions in various organs. The most recent up-to-date findings have been included in this exten valuable to all those interested in this rapidly expanding field.

Neuronal Gap Junction Protein Connexin 36 Expression and Function in the Developing Mammalian Retina

Regulation of Connexin43 and Astrocytic Gap Junctional Intercellular Communication in the Central Nervous System

Astrocytes in (Patho)Physiology of the Nervous System

Neuroglia in C. elegans

Intended for use by advanced undergraduate, graduate and medical students, this book presents a study of the unique biochemical and physiological properties of neurons, emphasising the molecular mechanisms that generate and regulate their activity.

Purpose Gap junctions are specialised intercellular conduits that link the cytoplasm of neighbouring cells. These channels permit the movement of small molecules between cells and play an important role in maintaining local homeostasis. Gap junctions are involved in the earliest cellular responses to injury and may modulate the response to central nervous system injury. This series of related studies aimed first to characterise the spatial and temporal expression of connexin43, the most abundant gap junction protein in the central nervous system, following retinal ischaemia-reperfusion injury and then to investigate connexin43 expression in the normal and diseased human eye. Methods Qualitative and quantitative analyses of connexin43 expression were performed using both an animal model and on donated human tissue. Unilateral retinal ischaemia-reperfusion injury was induced by elevating intraocular pressure to 120 mmHg for 60 minutes and then normalised in male Wistar rats. Post-mortem human eyes were obtained from the New Zealand National Eye Bank. Double-label fluorescent immunohistochemistry was used in combination with confocal microscopy to characterise the spatial and cell-specific expression of connexin43. To evaluate the relationship to astrocyte activation, glial fibrillary protein was assessed using immunohistochemistry and western blot analysis. In animal model studies, Evans blue dye leak from retinal vessels was used to assess vascular leakage and blood vessel integrity was examined using isolectin-B4 labelling. Retinal whole mounts and retinal ganglion cell counts were used to quantify neurodegeneration. Results Confocal microscopy generated high-quality images of retinal microstructure enabling precise cellular localisation of connexin43 antigen. Retinal ischaemia-reperfusion induced significant vascular leakage and disruption. Connexin43 immunoreactivity was significantly increased post ischaemia-reperfusion injury in both ischaemic and contralateral retinas, co-localising with activated astrocytes, Müller cells, and vascular endothelial cells. Subsequently, significant retinal ganglion cell loss was observed in the ischaemic eye with a trend toward loss in the contralateral eye. The subsequent studies established the pattern of connexin43 immunoreactivity in the normal and diseased human retina. Qualitative analysis using doublelabel fluorescent immunohistochemistry and confocal microscopy revealed connexin43 expression on glia, blood vessels, and epithelial cells in the normal human retina. Significant alterations were observed in eyes with primary open angle glaucoma. Key observations included increased connexin43 immunoreactivity at the level of the lamina cribrosa and in the peripapillary and mid-peripheral retina in association with glial activation. Conclusions These studies have provided important qualitative and quantitative data that add to our knowledge of the expression of connexin43 in health and disease.

The brain ... There is no other part of the human anatomy that is so intriguing. How does it develop and function and why does it sometimes, tragically, degenerate? The answers are complex. In Discovering the Brain, science writer Sandra Ackerman cuts through the complexity to bring this vital topic to the public. The 1990s were declared the "Decade of the Brain" by former President Bush, and the neuroscience community responded with a host of new investigations and conferences. Discovering the Brain is based on the Institute of Medicine conference, Decade of the Brain: Frontiers in Neuroscience and Brain Research. Discovering the Brain is a "field guide" to the brainâ€"an easy-to-read discussion of the brain's physical structure and where functions such as language and music appreciation lie. Ackerman examines: How electrical and chemical signals are conveyed in the brain. The mechanisms by which we see, hear, think, and pay attentionâ€"and how a "gut feeling" actually originates in the brain. Learning and memory retention, including parallels to computer memory and what they might tell us about our own mental capacity. Development of the brain throughout the life span, with a look at the aging brain. Ackerman provides an enlightening chapter on the connection between the brain's physical condition and various mental disorders and notes what progress can realistically be made toward the prevention and treatment of stroke and other ailments. Finally, she explores the potential for major advances during the "Decade of the Brain," with a look at medical imaging techniquesâ€"what various technologies can and cannot tell usâ€"and how the public and private sectors can contribute to continued advances in neuroscience. This highly readable volume will provide the public and policymakersâ€"and many scientists as wellâ€"with a helpful guide to understanding the many discoveries that are sure to be announced throughout the "Decade of the Brain."

Discovering the Brain

Gap Junction Channels and Hemichannels

Gap Junction Gene Expression in the Developing Nervous System

Astrocytes and Epilepsy

Cell-to-Cell Communication

Gap junction channels are a group of intercellular channels expressed in tissues and organs to synchronize many physiological processes. A gap junction channel is formed by the docking of two hemichannels, and each hemichannel is a hexamer of connexins. The field of gap junction channel and hemichannel research has recently exploded and became one of the most active areas of cell biology. Numerous novel approaches and techniques have been developed, but there is no single book dedicated to the unique techniques and protocols employed for the research on these large pore channels. This book fills the gap and focuses on protocols, approaches and reviews of gap junction channels and connexin hemichannels. It will be a useful reference for graduate students, postdoctoral fellows and researchers. Anyone with an interest in gap junction channels and hemichannels will need this summary of state-of-the-art techniques and protocols.

This book represents the proceedings of a NATO Advanced Research Workshop of the same name, held at St. Andrews University, Scotland in July of 1989. It was the first meeting of its kind and was convened as a forum to review and discuss the phylogeny of some of the cell biological functions that underlie nervous system function, such matters as intercellular communication in diverse, lower organisms, and the electrical excitability of protozoans and cnidarians, to mention but two. The rationale behind such work has not necessarily been to understand how the first nervous systems evolved; many of the animals in question provide excellent opportunities for examining general questions that are unapproachable in the more complex nervous systems of higher animals. Nevertheless, a curiosity about nervous system evolution has invariably pervaded much of the work. The return on this effort has been mixed, depending to a large extent on the usefulness of the preparation under examination. For example, work on cnidarians, to many the keystone phylum in nervous system evolution simply because they possess the "first" nervous systems, lagged behind that carried out on protozoans, because the latter are large, single cells and, thus, far more amenable to microelectrode-based recording techniques. Furthermore, protozoans can be cultured easily and are more amenable to genetic and molecular analyses.

Ay's Neuroanatomy of C. Elegans for Computation

Connexin Cell Communication Channels

Structural and Functional Aspects of Gap Junctions in Invertebrates

Gap Junctions in the Nervous System Through 1976

The Synaptic Organization of the Brain