

# Biochemistry & Molecular Biology 461 (BMB 461)

## Spring Semester 2017

### Lectures

11:30 a.m. – 12:20 p.m. MWF  
101 Biochemistry

### Instructor and Course Coordinator

Professor Kevin Haudek (Lectures 19, 20, 30-37)  
Biochemistry & Molecular Biology  
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### Other Instructors

Professor Charles Hoogstraten, (Lec. 1-9)  
Biochemistry & Molecular Biology  
302D Biochemistry Bldg.  
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Wed. 2:00.-3:30 p.m. or by email apt

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Professor Sophia Lunt (Lec. 21-29)  
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Dr. Anne-Sophie Bohrer (Lec. 38-41)  
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Office hour: Thurs. 11:00 a.m.-12:00 p.m.;  
3220 Molecular Plant Sciences (within Suite 3200)  
**Review: Tuesdays 5:00-6:30 p.m.** Location TBD

### Optional Weekly Review Sessions

Dr. Bohrer will lead weekly review sessions/recitations consisting of a short review presentation followed by an open question period. **You are strongly encouraged to take advantage of these opportunities for small-group instruction and to review important course material.** In addition, Dr Bohrer and other instructors will help answer questions posted on the Desire2Learn (D2L) Discussion Board and/or homework system.

### Textbook

**Required:** Nelson, D.L. and Cox, M.M. *Lehninger Principles of Biochemistry*, 6<sup>th</sup> ed. (2013). W.H. Freeman, New York. 1198 pages. This is the same textbook used by BMB 462.

The study guide associated with this textbook (*The Absolute, Ultimate Guide to Lehninger Principles of Biochemistry: Study Guide and Solutions Manual* by Marcy Osgood and Karen Ocorr, 6<sup>th</sup> ed., 2013) is completely optional, but many students have found it helpful in the past.

Using the older version of the textbook is an option, but if you elect to do so, you are responsible to match the required reading appropriately and note any updates. Alternatively, to save money you may elect to purchase a stand-alone on-line version of the textbook directly from the publisher (<http://www.macmillanlearning.com/Catalog/product/lehningerprinciplesofbiochemistry-sixthedition-nelson>).

## Course Objectives

BMB 461 is the first semester of the undergraduate series, BMB 461-462, which provides students with an introduction to biochemistry at the advanced undergraduate level. It is designed primarily for students majoring in Biochemistry or closely related field. BMB 461 is a three credit course that reintroduces basic biochemistry concepts including protein structure and function and focuses on carbohydrate and energy metabolism. The following topics will be discussed during this term:

- Buffers, pH
- Protein Structure
- Protein Purification
- Protein-Ligand Binding
- Enzyme Catalysis and Mechanism
- Enzyme Kinetics
- Carbohydrates
- Glucose Metabolism
- Pentose Phosphate Pathway
- Glycogen metabolism and regulation
- Citric Acid Cycle, Glyoxylate Cycle
- Electron Transport, Oxidative Phosphorylation
- Photosynthesis

For each of these topics you will be expected to apply basic biochemical principles to explain biological systems/processes and predict how alterations will impact these systems or processes.

## Course Expectation of Students

BMB461 is a rigorous, fast-paced, advanced biochemistry course. Students that complete the course routinely comment that it is one of the most challenging and rewarding classes at MSU. Habits of previously successful students include studying before or after every lecture, completing homework assignments regularly before the posted deadline, forming study groups and attending review sessions. By examining the textbook and course schedule, you will find that the course covers a lot of material each lecture and week. Be forewarned that academic success in this course will likely take a large amount of effort. The instructors are aware of the challenging nature of this course and have devised a course structure to accommodate these challenges (see appropriate sections below for specifics). For example, we enforce weekly homework deadlines to encourage you to keep up with the course content. The grading scale for each grade level is already lowered to accommodate the difficulty of exams and align with past semester performances of this course. Some notecards and calculators are permitted on exams in order to assist you with challenging exam questions. These aspects of the course are intended to help you be successful in this course. We encourage you to prepare yourself for success by devoting the required effort and time necessary for this course.

## Note on Introductory Material

BMB461 is an integrative course that draws on material covered in undergraduate biology, introductory chemistry, and organic chemistry. Chapter 1 of your textbook (*Lehninger Principles of Biochemistry*, D.L. Nelson and M.M. Cox, 6<sup>th</sup> ed.) provides a useful review of several topics from these prerequisite courses. We will not cover this material directly in lecture; students who encounter difficulty with terms, concepts, or calculations encountered are encouraged to consult this section of the book.

## Course Assessment

The grade in BMB461 will be based mainly on the three midterm exams given during class and the final exam (which covers Unit 4 and also has a cumulative portion) given during finals week (see course schedule). Each regular midterm exam is worth 19% of your grade and the final exam will be worth 28%, for a total of 85%. The remaining 15% will come from a mixture of scheduled clicker Checkup exercises (5%), in class clicker active learning (5%), and graded homework assignments (5%). Additional information about the clicker quizzes, active learning, and homework is given below. A total of 0.5% bonus can be earned for completion of optional online concept assessments at the beginning and end of the course. Please check D2L during the first and last week of class for these optional assessments. The table at right shows the grade that you will earn for attaining a given overall percentage.

| Grade | Percentage |
|-------|------------|
| 4.0   | ≥80.0      |
| 3.5   | ≥74.0      |
| 3.0   | ≥67.0      |
| 2.5   | ≥60.0      |
| 2.0   | ≥53.0      |
| 1.5   | ≥44.0      |
| 1.0   | ≥37.0      |
| 0.0   | <37.0      |

### 1. Clickers

This course will use i-clickers during lecture both to gauge your knowledge of some course content and to facilitate active learning. Clickers may be registered at the beginning of lecture any time during the first two

weeks of the semester. If you do not register your clicker during this time, you may not receive credit for previous clicker questions. *There are no make ups for points associated with clickers.*

### **a. Clicker “Check-up” Exercises**

There will be eight clicker Check-up exercises during the semester as indicated on the syllabus. These Check-up Exercises consists of several clicker questions given in succession at the beginning of a class period and scored as correct or incorrect for each question. In general, these exercises will be based on material you are expected to memorize, such as amino acid structures and abbreviations or specific assigned readings in the textbook. The material in each Check-up exercise will be explicitly identified in class prior to the assignment. Check-up questions will not represent the types of questions you can expect on exams. During the Check-up exercises you will not be allowed to use notes, books, calculators or talk with classmates or instructors. Your two lowest scores will be dropped at the end of the semester. The remaining Check-up exercises will be worth 5% of your final grade.

### **b. Active Learning**

During each lecture you will have one or more opportunities to answer questions using your i-clicker. You will receive 9/10th of a point for sending in any answer and an additional 1/10th of a point for sending in the correct answer. Some questions are designed to generate discussion and may not have a correct answer. In this case, you will receive one point for any answer. Your lowest four days of clicker scores will be dropped before calculating your final course grade. The active learning will be worth 5% of your grade.

Points associated with the clickers for the entire semester are worth a total of 10% of your final grade (5% for check-up exercises plus 5% for the active learning clicker questions). It is your responsibility to understand the feedback lights on your clicker and verify that your answers are received. If your clicker malfunctions during class, please notify the TA immediately. It is your responsibility to bring your clicker to class each day, and if you forget to bring your clicker or miss class for any reason, you will receive no points for that day. Because we drop your lowest clicker scores on clicker assignments, you can miss class occasionally for emergencies, religious days, or other commitments without seriously impacting your clicker scores.

## **2. Homework**

There will be required weekly online homework for this course. Instructions for registering and accessing the online homework will be delivered the first week of class. The homework assignments cover some of the concepts you need to know but is not exhaustive. You will have a homework assignment due each week and/or before each exam. The homework assignments will be open for several weeks before they are due, therefore, you are encouraged to work ahead. Technical difficulties or connection problems will not be valid excuses for missing a homework deadlines. Late homework assignments will not be accepted. Your lowest 2 weekly homework scores will be dropped at the end of the semester. All the remaining homework scores will account for 5% of your final grade, divided equally between the non-dropped assignments.

There will also be optional homework assignments that will neither be collected nor graded, but completing them will help you prepare for the exams. Finally, there are questions in the textbook at the end of each chapter, and you should incorporate these questions into your studies. The answers to these questions are provided in the back of the book. *Working in groups on all of the optional problem sets is encouraged.*

## **3. Exams**

The three midterm exams and the final exam will count for a total of 85% of your final grade. Each midterm exam will contribute 19% to your overall course grade; the final exam will count for 28% of your final course grade. Exams will contain a mixture of multiple choice and free response questions at the instructor's discretion. Calculators without Wi-Fi capabilities *will be allowed* on all exams. Calculators with Wi-Fi capabilities, cellphones, and other Wi-Fi devices *may not be used* during the exams. To encourage higher order learning, you may bring one handwritten, double-sided notecard to the exams with notes or equations you deem important. You will be provided with the proper notecard in the week preceding an exam by the instructor. You must use the notecard provided to write your exam notes. The notes must be hand written (i.e.

not typed or photocopied), and you must prepare your own note card. Thus, exams will de-emphasize simple memorization of facts. Material expected to be memorized will be covered on the Clicker check-up exercises. However, you should realize that your note sheets are limited in size and that there is a tradeoff between the amount of material written on those sheets and your ability to efficiently locate it during exams. A well-organized note card is a supplement to a solid understanding of the material rather than a replacement for it.

To ensure fairness, we have developed a set of rules. You will enter the room through the specified door(s) and will *be assigned to a seat by the instructor or test proctor*. Once you are in the room, refrain from talking to your classmates. You must not open the exam until instructed to do so. You will get warnings approximately 15 min and 5 min prior to the end of the exam. *Filling in any part of the exam after time has been called is considered cheating and will be dealt with accordingly!* When finished, you should put all portions of the exam into the appropriate boxes at the front of the room. You should not talk until you have left the room and/or all of the exams are collected. A copy of the exam with key will be posted when grades are available.

**Exam dates in this class are scheduled for February 3, February 24, March 31 and May 4.** The first three midterm exams will be given at the normal class time and in the normal classroom. Please check the final exam schedule for details about the final exam.

During exam weeks, instructors will lead optional “Question and Answer” sessions. In these weeks, the TA-led review session is replaced by the listed instructor-led review session. Information about these instructor-led Question-and-Answer sessions will be announced in class and posted to D2L during exam weeks.

### ***Absence from an exam***

If you will miss an exam due to travel to/from an MSU sponsored event or religious observance which can be anticipated in advance you must contact your instructor more than one week prior to the exam to determine if you are eligible for alternate exam arrangements.

If you unexpectedly miss an exam due to extenuating circumstances such as significant illness or death of a loved one, you must contact your instructor within 24 hours of the missed exam.

In order to be considered for make-up exam arrangements it is your responsibility to provide adequate documentation as requested by the instructor. You may or may not be eligible for a make-up exam based solely on the discretion of the instructor(s). If the instructor determines that you are not eligible for alternate exam arrangements and you do not/did not take the exam, you will earn a 0 on the exam.

For grief absences students must notify the Associate Dean or designee of their college of the need for a grief absence and must provide appropriate verification. The associate dean or designee will work with the student to determine the length of the absence and will notify faculty of the absence period. The policy on grief absence is described here: <https://reg.msu.edu/ROInfo/Notices/GriefAbsence.aspx>.

Make-up exams are administered at the instructor’s convenience, typically **within 48 hours of the original exam**. Make-up exams typically consist of essay questions but instructors retain the right to offer multiple choice makeup exams or exams of other formats in some circumstances.

### **Resources**

We will heavily rely on Desire2Learn (D2L) for the posting of lecture material. Students are expected to check these sites regularly for newly posted material. As members of a learning community, students are expected to respect the intellectual property of course instructors. All course materials presented to students are the copyrighted property of the course instructor. As such you may not post the recordings or other course materials online or distribute them to anyone not enrolled in the class without the advance written permission of the course instructor and, if applicable, any students whose voice or image is included in the recordings. Any student violating this restriction may face academic disciplinary sanctions.

## **1. Lecture Notes**

Lecture notes will be posted on D2L in advance of the lectures. These notes contain most figures discussed during lecture and are designed to aid your note taking during lecture and while reading the text. They are not a substitute for reading the textbook, nor do they contain all of the important information that will be presented in lecture. It is highly recommended that you print these lecture notes and read the assigned reading in the text prior to lecture, taking notes while you read. Then bring your notes to lectures to help fill in areas that were confusing to you when you first read them in the text.

## **2. Course Recordings**

Audio-video recordings of the lectures will be provided on D2L. The purpose of these recordings is to allow review of lectures as you study. **BMB 461 is not an online course, and these recordings are not a substitute for attending lectures and taking notes.** You should not depend on these recordings: some lectures may not be available or may be of poor quality due to technical difficulties and the server may go down at inopportune times. In addition, it is at the instructor's discretion to turn on the recording only after announcements regarding exams, etc. have been made.

## **3. Previous Exams**

Exams from a few previous semesters will be available in D2L. Please note that some of these exams may be from semesters when students were not allowed to bring a note sheet or calculator to the exam. You should expect a shift in the exams away from memorization and recall toward application and problem solving. The keys for free response questions will be posted no later than two days prior to each exam date.

## **4. Electronic Communications and Discussion Boards**

We will use the news feature or the e-mail feature in D2L to provide information about the course. Please be sure to check these regularly.

We will maintain a BMB 461 Discussion Board on D2L where questions can be posted. This should be your primary method for getting answers to questions related to general course content and mechanics. For questions that are personal in nature, for example related to missing an exam due to an absence, please email Prof. Haudek directly.

## **Honors Option**

Students may elect to take BMB461 with an H-option provided they obtain a grade of 3.0 or higher in the course. The honors option consists of a term paper that address an unsolved biochemical question related to one of eight topics provided by the instructors. Students interested in the honors option should check D2L during the first week of class for more information and deadlines.

## **Academic Integrity**

Academic honesty is expected. As discussed in the Spartan Life Student Handbook General Student Regulation Part 1, PROTECTION OF SCHOLARSHIP AND GRADES:

“The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University; therefore, no student shall:

1.01 claim or submit the academic work of another as one's own.

1.02 procure, provide, accept or use any materials containing questions or answers to any examination or assignment without proper authorization.

1.03 complete or attempt to complete any assignment or examination for another individual without proper authorization.

1.04 allow any examination or assignment to be completed for oneself, in part or in total, by another without proper authorization.”

You are authorized and encouraged to discuss graded homework problems with your classmates. However, it is expected that you will do your own work. Likewise, you are also encouraged to discuss active learning questions with your classmates. However, you must actually send in clicker answers with your own clicker. *Using multiple clickers to send in answers for classmates who are not present is academic dishonesty.*

All parts of the in-class Check-up exercises and exams are an individual effort, and you should neither give nor receive help during these assessments. Policies to ensure academic integrity will be strictly enforced. Any instance of academic dishonesty will result in a failing grade for that assessment and may result in a failing grade for the course.

### ***Requests for Accommodations***

Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at [rcpd.msu.edu](http://rcpd.msu.edu). Once your eligibility for an accommodation has been determined, you will be issued a verified individual services accommodation (“VISA”) form. Please present this form to Prof. Haudek at the start of the term or two weeks prior to the accommodation date. Requests received after this date will be honored whenever possible.

## BMB 461, Spring 2017 Lecture Schedule

| Date       | Lec   | Topic   | Reading          | Instructor  |
|------------|---|---|------------------|-------------|
| 1/9        | 1   | Aqueous solutions and pH  | 45-63            | Hoogstraten |
| 1/11       | 2   | Buffers; solving acid/base problems                                   | 63-70            | Hoogstraten |
| 1/13       | 3   | Amino acids and peptides; <b>Clicker exercise #1</b>                  | 75-89            | Hoogstraten |
| 1/16       | No Class – Martin Luther King Day   |   |                  |             |
| 1/18       | 4   | Proteins: Primary structure and evolution                             | 89-96            | Hoogstraten |
| 1/20       | 5   | Proteins: Secondary structure   | 115-125          | Hoogstraten |
| 1/23       | 6   | Proteins: Three-dimensional structure; <b>Clicker exercise #2</b>     | 125-143          | Hoogstraten |
| 1/25       | 7   | Proteins: Structure and Folding                                       | 143-151          | Hoogstraten |
| 1/27       | 8   | Protein purification  | 89-96            | Hoogstraten |
| 1/30       | 9   | Protein-ligand binding: Myoglobin and hemoglobin                      | 157-174          | Hoogstraten |
| 2/1        | 10  | Enzyme catalysis and mechanism  | 189-200          | Jin         |
| 2/2        | Optional Q and A by Instructor: 5:30- 7:00 p.m.; location TBA   |   |                  |             |
| 2/3        | <b>Exam I: Through Lecture 9</b>  |   |                  |             |
| 2/6        | 11  | Enzyme catalysis and mechanism  | 214-221          | Jin         |
| 2/8        | 12  | Enzyme kinetics: Introduction   | 200-207          | Jin         |
| 2/10       | 13  | Enzyme kinetics: Inhibition; <b>Clicker exercise #3</b>               | 207-213          | Jin         |
| 2/13       | 14  | Enzyme kinetics: Regulation and allostery                             | 226-236          | Jin         |
| 2/15       | 15  | Enzymology and medicine: The cytochrome P450 system                   | 844-845          | Jin         |
| 2/17       | 16  | Bioenergetics: Principles   | 501-517          | Jin         |
| 2/20       | 17  | Bioenergetics: High-energy compounds and phosphoryl transfer          | 517-527          | Jin         |
| 2/22       | 18  | Bioenergetics: Redox reactions and energy balance; <b>Cl. Exer.#4</b> | 528-537          | Jin         |
| 2/23       | Optional Q and A by Instructor: 5:00-6:30 p.m.; location TBA  |   |                  |             |
| 2/24       | <b>Exam II: Through Lecture 18</b>  |   |                  |             |
| 2/27       | 19  | Carbohydrates: I  | 243-253          | Haudek      |
| 3/1        | 20  | Carbohydrates: II   | 254-268          | Haudek      |
| 3/3        | 21  | Introduction to metabolic pathways                                    | 501-504; 543-547 | Lunt        |
| 3/6 – 3/10 | No Class – Spring Break   |   |                  |             |
| 3/13       | 22  | Glucose metabolism: Glycolysis  | 548-563          | Lunt        |
| 3/15       | 23  | Glucose metabolism: Glycolysis  | 548-563          | Lunt        |
| 3/17       | 24  | Glucose metabolism: Glycolysis and Fermentation                       | 563-568          | Lunt        |
| 3/20       | 25  | Glucose metabolism: Gluconeogenesis; <b>Clicker exercise #5</b>       | 568-575          | Lunt        |
| 3/22       | 26  | Regulation of Glycolysis and Gluconeogenesis                          | 587-595, 601-612 | Lunt        |
| 3/24       | 27  | Pentose phosphate pathway   | 575-580          | Lunt        |
| 3/27       | 28  | Pentose phosphate pathway   | 575-580          | Lunt        |
| 3/29       | 29  | Pyruvate dehydrogenase complex; <b>Clicker exercise #6</b>            | 633-638          | Lunt        |
| 3/30       | Optional Q and A by Instructor: 4:00- 5:30 p.m.; location TBA   |   |                  |             |
| 3/31       | <b>Exam III: Through Lecture 29</b>   |   |                  |             |
| 4/3        | 30  | Citric acid cycle   | 633-647          | Haudek      |
| 4/5        | 31  | Citric acid cycle and Glyoxylate cycle                                | 647-659          | Haudek      |
| 4/7        | 32  | Mitochondrial electron transport                                      | 731-747          | Haudek      |
| 4/10       | 33  | Mitochondrial electron transport                                      | 731-747          | Haudek      |
| 4/12       | 34  | Oxidative phosphorylation; <b>Clicker exercise #7</b>                 | 747-759          | Haudek      |
| 4/14       | 35  | Oxidative phosphorylation   | 759-768          | Haudek      |
| 4/17       | 36  | Glycogen metabolism   | 612-620          | Haudek      |
| 4/19       | 37  | Regulation of glycogen metabolism                                     | 620-627          | Haudek      |
| 4/21       | 38  | Photosynthesis: Light-driven ATP synthesis                            | 769-791          | Bohrer      |
| 4/24       | 39  | Photosynthesis: Light-driven ATP synthesis                            | 769-791          | Bohrer      |
| 4/26       | 40  | Photosynthesis: Carbon fixation; <b>Clicker exercise #8</b>           | 799-821          | Bohrer      |
| 4/28       | 41  | Photosynthesis: Carbon fixation                                       | 799-821          | Bohrer      |
| 5/3        | Optional Q and A by Instructor: 5:00 – 6:30 p.m.; location TBA  |   |                  |             |
| 5/4        | <b>Final Exam 150 pts total: 100 pts Lectures 30- 41 and 50 pts Cumulative<br/>10 a.m. – 12 p.m. 101 Biochemistry</b> |   |                  |             |

*Note that exam dates are fixed, but the exact material on exams may vary due to the pace of the course.*

Biochemistry and Molecular Biology (BMB) is a peer-reviewed and open access journal that provides an international forum for researchers, scholars and practitioners of biochemistry and molecular biology to share experiences and communicate ideas. It is to publish refereed, well-written original research articles that describe the latest research and developments in the area of biochemistry and molecular biology. Articles may discuss fundamental or applied issues, and should offer clear evidence of novelty and significance. The topics related to this journal include but are not limited to: • Biochemistry & Molecular Biology. Upper Division Requirements, Sample 4-yr Plans, Elective List. Housed within the Division of Biochemistry, Biophysics, & Structural Biology, the Biochemistry and Molecular Biology (BMB) emphasis is dedicated to the mechanistic understanding, at the molecular level, of essential processes for the life of the cell. To this end, the BMB emphasis uses rigorous and reductionist approaches to describe living systems in chemical and physical terms. Unique to BMB is the combination of powerful molecular biological methodologies (e.g. cloning, gene splicing and



Contemporary topics in Biochemistry and Molecular Biology (BMB). Using primary research articles that underlie scientific news in popular press, students participate in weekly discussions and give at least one group presentation. Students learn and develop practical skills in critical reading and presentation of primary research findings. Components: LEC. Grading: GRD. Typically Offered: Fall & Spring. BMB 260. Introduction to Biochemistry and Nutrition. KEY FEATURES • Integrates basic biochemistry principles with molecular biology and molecular physiology • Provides translational relevance to basic biochemical concepts through medical and physiological examples • Utilizes a systems approach to understanding biological phenomena. DESCRIPTION Biological Chemistry is supported by over forty years of teaching experience, providing coverage of basic biochemical concepts, including the structure and physical and chemical properties of hydrocarbons, lipids, proteins, and nucleotides in a straightforward and easy to comprehend language. Biochemistry and Molecular Biology 461 (BMB461) - Advanced Biochemistry I 11:30 a.m. -12:20 p.m.; MWF 101 Biochemistry Spring semester 2020. Contact Information. Instructor Information. Dr. Kevin Haudek Course coordinator Phone: 353-4377 haudekke@msu.edu (must include "BMB461" in subject line). Course Expectations of Students. BMB461 is a rigorous, fast-paced, advanced biochemistry course. Students that complete the course routinely comment that it is one of the most challenging and rewarding classes at MSU. Habits of previously successful students include studying before or after every lecture, completing homework assignments regularly before the posted deadline, forming study groups and attending review sessions. Bmb 461 advanced biochemistry 1. School: Michigan State University (MSU). \* Professor: Eric Anderson, {[ professorsList ]}. Eric Anderson, Stoltzfus, Benning, HEGG/BENNING, STAFF, unknown, SHARKEY, Hegg, Hoogestraten, Benning, DWORKIN, huddek. \* We aren't endorsed by this school. ADVANCED BIOCHEMISTRY 1. BMB 461 - Spring 2011. Register Now. BMB471. 3 pages. Homework7Solutions bmb 461. Michigan State University. Introductory physical chemistry I. BMB 461 - Spring 2012. Guha M, Bai W, Nadler JL, Natarajan R. Molecular mechanisms of tumor necrosis factor alpha gene expression in monocytic cells via hyperglycemia-induced oxidant stress-dependent and -independent pathways. J Biol Chem 2000;275:17,728-17,739. Google Scholar. 38. Sakamoto K., Brownlee M. (2003) Biochemistry and Molecular Biology of Diabetic Complications. In: Sperling M.A. (eds) Type 1 Diabetes. Contemporary Endocrinology.