



### Connections to Curriculum

- ✓ Demonstrate Understanding
- ✓ Decision Making
- ✓ Group Work
- ✓ Information Management
- ✓ B11-2-07 Describe the homeostatic role of the liver with respect to the regulation of nutrient levels in the blood and nutrient storage.
- ✓ B11-2-12 Use the decision-making process to investigate an issue related to digestion and nutrition.

### Senior Years Science Teachers' Handbook

- Chapter 12: Reading Scientific Information
- ✓ 12.9 During Reading Strategies
  - ✓ 12.12 Collaborative Reading
  - ✓ 12.14 Reciprocal Teaching
  - ✓ 12.22 Question-Answer Relationships (QAR)

## Unit 2

# Digestion and Nutrition

### *Liver Transplant Lesson Plan*

### Objectives

Students will

- review functions of the liver
- organize information from a written source
- evaluate situations where an organ transplant is necessary and make decisions as to who will receive the organ

### Materials

- Liver Transplant: Prereading Questions (BLM 2.1) (one per student)
- Wanted: Liver: Case Study of the Necessity for Liver Allocation (BLM 2.2) (one per student)
- Liver Transplant: Post-reading Analysis (BLM 2.3) (one per student)

*Note: This case study is recommended as reinforcement to SLO B11-2-07, while at the same time making information applicable to a real world setting of organ transplantation.*

### Anticipatory Set

1. Hand out the Liver Transplant: Prereading Questions (BLM 2.1) and ask students to review the functions of the liver and label the diagram provided.

### Lesson

1. Hand out Wanted: Liver: Case Study of the Necessity for Liver Allocation (BLM 2.2) to the class. Read the studies aloud one at a time, or have students read the case studies aloud, one paragraph at a time.
2. Ask students to organize the information from the case study by filling out the Liver Transplant: A Post-reading Analysis form (BLM 2.3).
3. Have students reflect on the information provided by answering the discussion questions, individually at first.

*(continued)*

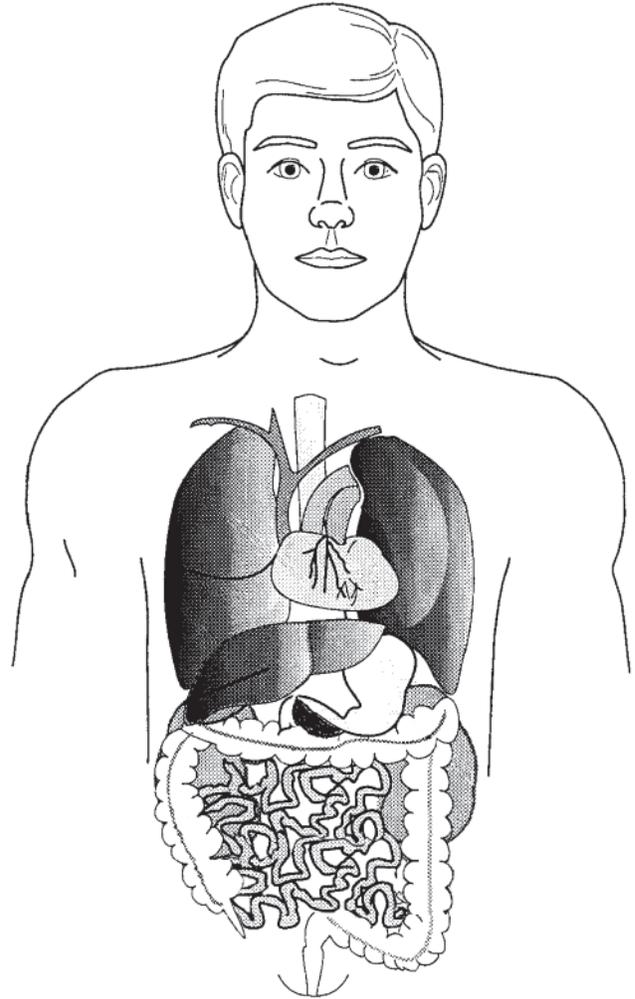
## **Assessment/Closure**

1. To facilitate group discussion, divide class into groups (after written answers have been completed in class or at home) and assign each group a question to discuss. Each group comes to a group consensus, records their response on chart paper, and presents it to class.
2. To aid discussion, have six groups in the class, two groups per discussion question. When presenting group answers, have both groups present answers at the same time, and ask the class to describe discrepancies in the answers provided.

## Liver Transplant: Prereading Questions

1. Identify and label the liver on the diagram to the right.
2. List four discrete and independent functions of the liver.

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3. Explain how the liver is involved in the regulation of blood glucose levels after a meal high in carbohydrates is consumed. You may use a negative feedback cycle in your answer.

4. What factors must be considered before a patient can be considered for a liver transplant?

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5. a. Can liver transplant recipients receive donations from live donors? Explain.

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- b. Would your answer in (a) above change if the recipient required a heart from a live donor rather than a liver? Explain.

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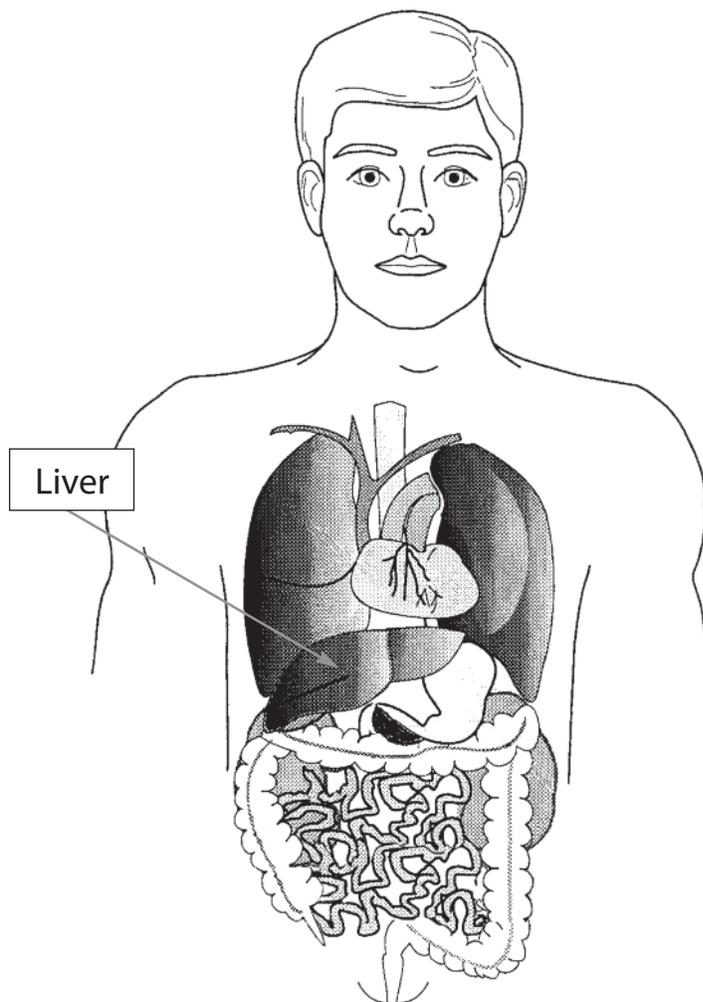
**Read the case study provided.**

**Teacher Note:**

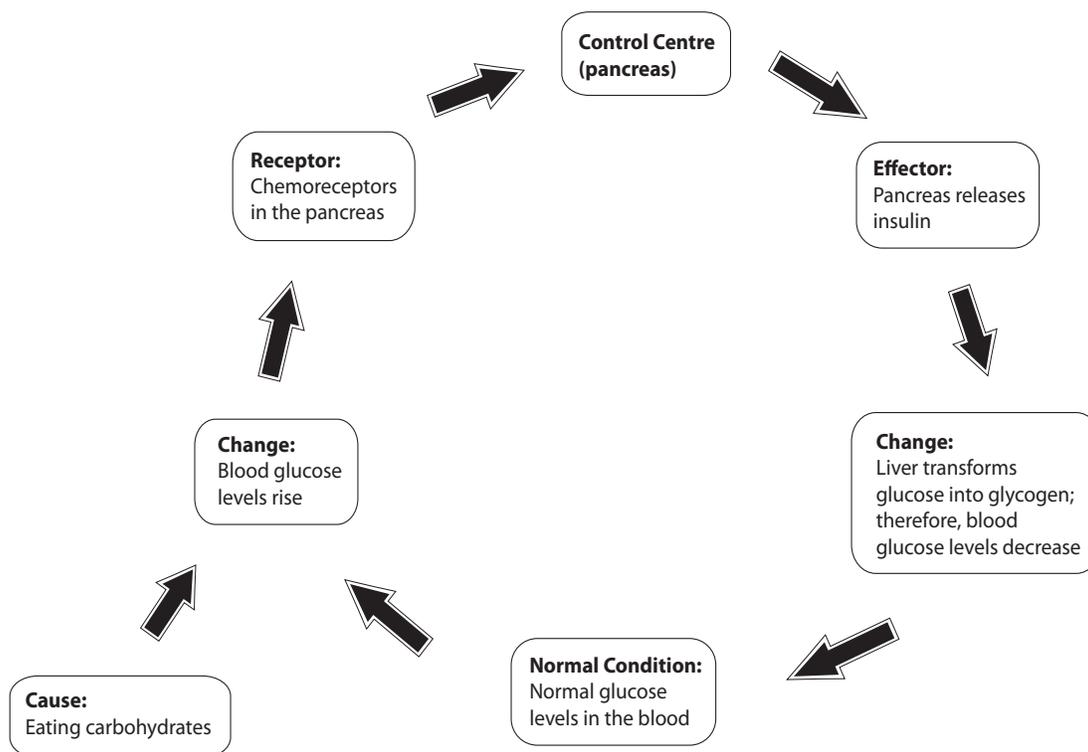
It is recommended that students have satisfactorily achieved Specific Learning Outcome B11-2-07 and have acquired the information cited in Appendix 2.4A of the Grade 11 Biology curriculum document.

## *Liver Transplant: Prereading Questions*

1. Identify and label the liver on the diagram to the right.
2. List four discrete and independent functions of the liver.
  - **stores and releases nutrients and vitamins**
  - **manufactures bile**
  - **aids in blood sugar regulation**
  - **detoxifies blood**



3. Explain how the liver is involved in the regulation of blood glucose levels after a meal high in carbohydrates is consumed. You may use a negative feedback cycle in your answer.



4. What factors must be considered before a patient can be considered for a liver transplant?
- **patient condition (overall health, location in proximity to available organ)**
  - **donor/organ condition (is the liver in overall good health?)**
  - **patient/donor compatibility (blood tests, HLA matches, etc.)**
5. a. Can liver transplant recipients receive donations from live donors? Explain.

**Yes, the liver is the only human organ that regenerates. As long as the patient and donor are “matches,” the donor can give a portion of his/her liver (a portion of a lobe) and the portion will not only regenerate in the donor but also continue to generate in the recipient.**

- b. Would your answer in (a) above change if the recipient required a heart from a live donor rather than a liver? Explain.

**Yes. A person cannot donate a portion of their heart while they are alive. An individual requires their whole heart to live. The heart does not regenerate.**

**Read the case study provided.**

## **WANTED: Liver**

### **Case Study of the Necessity for Liver Allocation**

#### **Case #1: Justin's Story:**

Justin was a healthy 18-year-old male. He graduated from high school the previous June and spent the summer working at his part-time job in a local hardware store and spending time with friends, camping. On his camping trips, Justin and his friends would relax and relive their high school memories, occasionally with some alcohol on hand. He maintains that he has never drunk to excess. On one certain camping trip, a friend offered the drug ecstasy to the group. Justin, who admittedly tried marijuana recreationally, had never tried ecstasy and joined in with his friends in trying the drug. Over the course of time while on the drug, Justin became extremely overheated, sweated profusely between momentary instances of chills, and became very thirsty. In the morning, Justin had a huge headache and found that his body craved liquid, so he drank water continuously. Everyone's metabolism is different and their bodies treat the drug in a different manner, but in Justin's case, his reaction was typical among his friends.

Justin still lived with his parents, with whom he had a good relationship; however, on his return home he did not mention his experience with the drug while on the camping trip. His attentive mother and father noted that Justin was extremely exhausted after his weekend trip and allowed him to rest upon his return and provided him with lots of water. A few days later, both Justin and his family forgot about the weekend camping trip.

A few weeks went by and Justin began technical college studying the electrical trade. He enjoyed his studies, and was making new friends in his new school. Justin continued working his part-time job.

Halloween approached, and Justin was invited to a Halloween social with friends and acquaintances from school. At the social, someone Justin did not know offered ecstasy to the group Justin was standing among. Everyone grabbed a tablet, including Justin.

Justin's reaction to the drug in this instance was much the same as his first exposure—at first. The next day, he found himself tired and thirsty again, and treated his symptoms much the same, but two weeks later his health took a much different turn.

Justin's parents noticed that his skin and the whites of his eyes had a slight yellow tinge, and Justin was complaining of a fever. When he was a baby, Justin was afflicted with similar symptoms, as are many infants. Justin's mother immediately recognized this as being jaundice and remembered the doctor explaining that Justin's liver was failing to process a chemical component of bile (a green-yellow liquid used in the physical digestion of fat) called bilirubin. Bilirubin is made from the breakdown of red blood cells—a process known as hemolysis which occurs in the liver. The bilirubin is what gives bile the green-yellow colour, and since it was not being transferred to bile in the liver, it was instead becoming trapped in the fatty tissue layers in Justin's skin, causing his skin to appear yellow.

Justin's mother took him to the hospital to have this condition treated, although she did not realize that this time, the jaundice was much more serious than when he was a baby. Justin's skin continued to yellow and his fever continued to rise. Within hours of being at the hospital, Justin slipped into a coma and had to be admitted to the intensive care unit as a priority.

His liver was beginning to fail completely; jaundice was merely an early warning sign. Toxicology reports showed that this was due to an adverse reaction to the drug ecstasy. Doctors explained to his parents that reactions to the drug may not appear immediately after consumption. Justin's parents assumed that the drug must have been ingested at the Halloween social their son attended two weeks prior. They then deduced that he must have also consumed it over the summer as well, based on common symptoms. Doctors explained that because drugs come from different sources, they may have different ingredients—ingredients that Justin's body may or may not be able to metabolize. The second dosage of the drug could not be processed by Justin's liver, and caused this vital organ to enter into failure.

Soon after, Justin was transferred via air ambulance to the local transplant centre where his condition continued to deteriorate. His parents accompanied him. One day after his arrival at the centre, Justin's parents were informed that the only treatment that could save Justin's life was a liver transplant. Justin was in dire need of a new liver.

### **Case #2: Michelle's Story**

Michelle is a 32-year-old single mother with a young child and has a history of liver problems that began shortly after Michelle received a blood transfusion 17 years prior, when she was 15 years old. Michelle needed the transfusion following a car accident in which she suffered numerous injuries. After suffering from nausea and fatigue for quite some time, she began to lose a lot of weight and developed pain over the right side of her abdomen. When she was 20 years old, Michelle was diagnosed with hepatitis C, a blood-borne disease that doctors traced back to her blood transfusion years earlier.

As a result of being diagnosed with hepatitis C, Michelle immediately stopped consuming alcohol in an effort to not put excess stress on her liver. She has been alcohol-free for 12 years and has never used intravenous drugs (even though her ex-husband and father of her child is in jail for trafficking narcotics) but admits to using marijuana in her youth.

Michelle's disease is progressing and she is beginning to show the early signs of jaundice—her skin is beginning to turn a slightly yellow colour, a indication of liver failure. Even though Michelle is extremely slim, her belly is beginning to distend (swell). Doctors have told her that this is a sign of cirrhosis of the liver. Michelle knew that cirrhosis was a disease typically associated with alcoholism, but doctors explained that it's linked to hepatitis in that healthy liver tissue is replaced with non-functioning scar tissue causing the body to react by developing, among other things, jaundice, distension of the abdomen, fatigue, and lethargy.

Michelle lives in the same city as her parents, her older brother and his family. Due to her ex-husband's incarceration, Michelle has sole custody of her six-year-old daughter, and they live in a townhouse, supported by a government disabilities pension.

Due to the serious and rapid deterioration of her liver, Michelle has been placed on a liver transplant waiting list. She is anxious to receive a new liver and continue to raise her young child. Michelle's long-term goal, when she is healthy enough, is to return to school and become a lawyer. Michelle's daughter does not realize the gravity of her mother's health condition, but often questions who will look after her "when mommy goes away."

Michelle was looking forward to getting on with her new life. However, her disease progressed to the point of her requiring hospitalization. Her parents began looking after her daughter. After a week, Michelle rose to the top of the liver transplant waiting list and was to receive the next available and suitable liver. She is blood type O, which is the same blood type as Justin.

## *Liver Transplant: Post-reading Analysis*

### **Case #1**

Name and Age of Patient	Background Information about Patient
Cause of Liver Failure	
Symptoms of Liver Failure	
Prognosis/Treatment Options Available	

### **Case #2**

Name and Age of Patient	Background Information about Patient
Cause of Liver Failure	
Symptoms of Liver Failure	
Prognosis/Treatment Options Available	

## Discussion Questions

1. What are some of the differences between Justin's and Michelle's conditions and reasons for needing a liver transplant?

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2. Assume you are the head of the transplant team that is assigned to both Justin and Michelle, who are both placed on the transplant list. On what basis would you make the decision of which person is the priority for the next liver that becomes available?

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3. Using your answer to question #2, how would you explain to the other patient and his or her family why the next available liver is not going to him or her?

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## Liver Transplant: Post-reading Analysis

### Case #1

<p>Name and Age of Patient</p> <p><b>Justin, 18</b></p>	<p>Background Information about Patient</p> <ul style="list-style-type: none"> <li>• <b>high school graduate</b></li> <li>• <b>good relationships with family and friends</b></li> <li>• <b>recreational drug use</b></li> </ul>
<p>Cause of Liver Failure</p> <p><b>Drug use—Ectasy</b></p>	
<p>Symptoms of Liver Failure</p> <ul style="list-style-type: none"> <li style="width: 50%;">• <b>tired and thirsty</b></li> <li style="width: 50%;">• <b>yellowing of eyes</b></li> <li style="width: 50%;">• <b>jaundice (yellowing of skin)</b></li> <li style="width: 50%;">• <b>fever</b></li> </ul>	
<p>Prognosis/Treatment Options Available</p> <p><b>Liver Transplant</b></p>	

### Case #2

<p>Name and Age of Patient</p> <p><b>Michelle, 32</b></p>	<p>Background Information about Patient</p> <ul style="list-style-type: none"> <li>• <b>single mother</b></li> <li>• <b>17 years of treatment for liver health, including hospitalization</b></li> <li>• <b>does not drink/no drugs</b></li> <li>• <b>cannot work due to liver deterioration</b></li> <li>• <b>on wait list for liver transplant</b></li> <li>• <b>blood type O (same as Justin)</b></li> </ul>
<p>Cause of Liver Failure</p> <p><b>Hepatitis C (due to blood transfusion)</b></p>	
<p>Symptoms of Liver Failure</p> <ul style="list-style-type: none"> <li style="width: 50%;">• <b>cirrhosis of the liver</b></li> <li style="width: 50%;">• <b>yellowing of skin (jaundice)</b></li> <li style="width: 50%;">• <b>lethargy</b></li> <li style="width: 50%;">• <b>swelling of belly</b></li> <li style="width: 50%;">• <b>fatigue</b></li> </ul>	
<p>Prognosis/Treatment Options Available</p> <p><b>Hospitalization, liver transplant</b></p>	

## Discussion Questions

1. What are some of the differences between Justin's and Michelle's conditions and reasons for needing a liver transplant?

**Student-led discussion:** \_\_\_\_\_

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**Student-led discussion:** \_\_\_\_\_

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**Student-led discussion:** \_\_\_\_\_

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