This section consists of selected pages from the Lab Manual & Study Guide containing answers to chapter quizzes and suggested answers for worksheets where definite answers can be provided.
My Personal Definition of "Physical Literacy"

[Students should construct a definition of physical literacy that incorporates central ideas of the PHE Canada definition on p. 18 and they should list examples of physical activities they pursue in their daily lives and how these activities have benefitted them personally.]

"Competence and confidence in a wide variety of physical activities in multiple environments."
1.4 What Is Kinesiology?

Over the past 50 years or so, kinesiology has been the fastest growing discipline at colleges and universities. The study of kinesiology can provide a strong entry point to a lifelong career in many fascinating fields.

**MISSION:** In this exercise, you are encouraged to expand the concept map below that represents the components of kinesiology as a field of study. (The graphic is the same as the one on page 25 in your textbook.) On the lines provided, jot down topics related to each component of the field of kinesiology. Feel free to refer to your textbook to check to see whether your suggested topics are directly related to the discipline of kinesiology.

**Anatomy**
- Physiology
- Biology
- Physiotherapy
- Medicine

**Exercise Physiology and Anatomy**

**Biomechanics, Motor Learning, and Skill Acquisition**
- Sports instruction
- Coaching
- Sports equipment design
- Study of child development
- Design of prosthetics

**The Discipline of Kinesiology**

**Social, Psychological, and Historical Aspects of Sport**
- Sport consumerism
- Sport psychology
- Wellness consulting
- Health promotion
- Physical education

**Fitness Training, Recreation, and Leisure**
- Fitness appraisal
- Dance
- Recreational therapy
- Youth program coordination
- Outdoor education

Name: ____________________________
Date: ____________________________
WORKSHEET

Chapter 1 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 1. Complete each set of questions according to your teacher's instructions.

Question Set 1: Inactivity and Obesity—Overcoming the Barriers

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. The Latin expression Mens sana in corpore sano means
   (a) an agile mind in an athletic body
   (b) a clear mind in a muscular body
   (c) a wise mind in an aging body
   ✓ (d) a sound mind in a healthy body

2. Dr. John Ratey and other brain researchers have demonstrated that physical activity
   (a) increases energy levels
   (b) enhances mood
   (c) improves memory
   ✓ (d) all of the above

3. Insufficient physical activity around the world is associated with
   ✓ (a) increased morbidity and mortality worldwide
   (b) decreased industrial safety worldwide
   (c) a declining birth rate worldwide
   (d) lower income levels worldwide

4. What is the basic physical activity target for adults in Canada in terms of moderate to vigorous exercise per week?
   (a) 75 minutes
   ✓ (b) 150 minutes
   (c) 250 minutes
   (d) 100 minutes

5. The ratio of a person's weight in kilograms to the square of his or her height in metres is known as
   (a) DALYs
   (b) CAD
   ✓ (c) BMI
   (d) MRI

6. One of the main culprits contributing to lifestyle diseases in industrialized countries, as identified by the World Health Organization, is
   ✓ (a) sedentarism
   (b) air pollution
   (c) autoimmune deficiency
   (d) overreliance on prescription drugs

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. List some ways in which daily life in developed nations has reduced people's opportunities to expend physical energy.
   Urbanization (sedentary office jobs, etc.; increased availability of motorized transportation to replace walking and bike riding; the mechanization of labour).

2. What is meant by the "built environment"?
   The human-made surroundings that provide the setting for human activity, ranging in scale from buildings and parks to neighbourhoods and cities, including infrastructure.

3. What three recommended behavioural changes can prevent most lifestyle diseases?
   Avoid smoking; eat a healthy diet and maintain a healthy weight; maintain appropriate daily physical activity and limit TV watching and other sedentary pursuits.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Discuss the effects of physical activity on mental performance.

2. Explain why health experts believe that the physical inactivity crisis is threatening the health of multiple generations of Canadians.

3. Describe and evaluate the most effective ways to overcome barriers to physical activity.
Question Set 2: Physical Literacy and the Study of Kinesiology

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. The key to physical literacy lies in
   (a) more funding for Canadian Sport Centres
   (b) publicity campaigns to promote healthy living
   (c) tax breaks for parents or guardians who enrol their children in recreational programs
   ✓ (d) strong physical education programs at the school level

2. The main focus of amateur hockey leagues is
   (a) learning team skills
   (b) teaching athletes to have fun
   ✓ (c) improving the competitive level of the sport
   (d) supporting amateur hockey in Canada

3. The benefits of community sport and physical activity programs include
   (a) reduced smoking, drug use, and alcohol consumption
   (b) support services for at-risk youth and newcomers to Canada
   (c) decreased incidence of illness and injury
   ✓ (d) all of the above

4. Sport and recreation create what sociologists refer to as
   (a) human capital
   (b) physical capital
   ✓ (c) social capital
   (d) monetary benefits

5. According to the Long-Term Athlete Development (LTAD) model, children do best when they engage in activities that suit their
   ✓ (a) developmental level
   (b) grade level
   (c) chronological age
   (d) height and weight

6. The LTAD model focusses on
   ✓ (a) Canadian national sport policy
   (b) a training, competition, and recovery pathway
   (c) intramural sports
   (d) amateur athletics

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. Name at least three national and provincial organizations that are spearheading the physical literacy campaign in schools.
   Physical and Health Education Canada (PHE Canada), the Ontario Physical and Health Education Association (Ophea), the Canadian Intramural Recreation Association (CIRA), and School Sport Canada.

2. Name the apparently harmless act that has been described as a “deadly killer in our midst.”
   The seemingly harmless act of sitting for long periods of time increases the risk of diabetes, heart disease, and death.

3. List four different occupational areas associated with a degree or diploma in kinesiology.
   Exercise physiology; physical education; recreation and leisure; and health education.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Discuss ways to reduce concerns about children's safety in order to boost participation in informal games and unstructured activities in playgrounds, fields, and parks.

2. Explain how Canadian Sport for Life's Long-Term Athlete Development (LTAD) model is one of its most important cornerstones.

3. What are some ways to enter the field of kinesiology?
## 2.1 Sporting Values—An Historical Timeline

Physical activity and sport are intricately linked to society as a whole. The predominant societal attitudes and values of a specific time period are often reflected in the sporting values of that period as well.

**MISSION:** Demonstrate your understanding of the relationship between societal values and sporting values in three different historical time periods.

Fill in the timeline chart on these two pages to the best of your ability, and then answer the discussion questions that appear at the top of the next page.

<table>
<thead>
<tr>
<th>1. The Early Period: Ancient Greeks and Romans</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Describe the social significance of physical activity and sport during this time period. What main purposes or roles did physical activity and sport fulfill for society?</strong></td>
</tr>
<tr>
<td>The original Olympics were a part of religious celebrations honouring the god Zeus. The Greeks believed that the gods bestowed extraordinary physical abilities upon athletes, and winners would present offerings to the temples of the gods. The Games provided an opportunity for much-admired young male athletes to demonstrate their physical strength and fitness.</td>
</tr>
</tbody>
</table>

| 2. What would you say were the predominant societal values that characterized this time period? |
| Worship of Greek and Roman gods was an important religious and social practice and human activities such as sports were performed in homage to the gods. Society was male-dominated and oriented towards war, military conquest, and the glory of the Greek nation state and the Roman Empire. Slavery was an accepted part of the social structure. Society was hierarchical, i.e., divided into distinct classes according to lineage, wealth, political power, and military rank. |

| 3. What would you say were the predominant sporting values that characterized this time period? |
| Participation in sports was valued as a means to attaining both physical and mental well-being—the ideal of “a sound mind in a healthy body” was highly prized. The high value placed on friendly athletic competition among nations was symbolized by the Olympic truce (peace) that permitted nations to participate in the Games in a peaceful setting even if they were at war with one another. |

| 4. How equitable was access to physical activity and sport as leisure pursuits during this time period? Explain your answer. |
| Access to physical activity and sport as leisure pursuits was not equitable; only men of a high social standing were allowed to compete in the ancient Olympics, for example. Married women were not allowed to watch Olympic events, but unmarried women were permitted to attend the Games. Women and citizens of lower social status were not allowed to compete in the Games. |
### Discussion Questions

1. There is a clear connection between societal values and sporting values. Do you think that societal values are reflected in sporting values, or vice-versa? Explain using examples.

2. As Western society has evolved, do you perceive an increase or a decrease in access to physical activity and sport? Give examples of social groups that had and did not have access to sport and physical activity in the past.

3. What important societal values do you think can be reinforced through sport today? Where do you see societal values and sporting values shifting in the future?

4. How can international sport competitions, such as the Olympics, help to promote a greater understanding of the cultures and values of other nations? What importance do these events hold for world societies?

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#### The Industrial Revolution and the Victorian Era

Sport and athletics became "leisure" pursuits for the privileged upper classes, and eventually, for the new middle class—participation in sport symbolized an individual's "gentlemanly" social status.

The upper classes enjoyed riding, hunting, and other outdoor activities on their large country estates. The Industrial Revolution gave rise to a new, prosperous middle class who aspired to join in the same leisure pursuits enjoyed by the upper classes.

The Victorians believed that sports developed "manly character" and camaraderie.

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#### The Modern Period (The 1896 Olympics and Beyond)

In 1896, French educator Pierre de Coubertin revived the ancient Olympics as a modern international sporting competition to promote the ideal of "a sound mind in a healthy body" and to prepare young French soldiers for battle.

The revived Games honoured the principles of competing against the best and focussing on the competition rather than the prize. Gradually, sport and physical education shifted from a model based on militaristic discipline and training to one that emphasized school and team spirit, pursuing one's "personal best," having fun, and reaping social and health-related rewards as well.

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Sport was valued as "character-building" and important to the education of privileged young men. Amateurism—playing sport for recreation and not as a profession—was an important ideal.

This era saw the emergence of many new outdoor competitive sports, e.g., golf, hockey, soccer, football, and rugby requiring well-developed physical skills and set rules of play. Genteel "leisure pursuits" such as cricket and tennis became popular.

There was also an increase in the numbers of spectators attending sporting events as a form of social entertainment.

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The modern Olympics aimed to promote sporting values that overlapped with societal values, e.g., international understanding and cooperation; tolerance; amateurism, and nationalism.

The modern era saw an increase in appreciation for elite-level athleticism; elite athletes gained ever-increasing social status and recognition, sometimes to the point of "superstardom."

At the same time, ordinary citizens began to place an increasing value on performing physical activities for the sake of enjoyment, self-improvement, and health benefits.

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The ideal of "amateurism" excluded lower classes from competing in sporting events.

For the most part, the upper and middle classes were the only members of society with the leisure time and financial resources to enjoy participating in organized sports and games.

Women were excluded from participating in many sports and physical activities because the Victorian "feminine ideal" viewed physical activity as risking potential harm to a woman's "delicate constitution."

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The first modern Olympic Games in 1896 did not embrace equity: they excluded women, people of colour, and people with disabilities—only able-bodied, white European "gentlemen" were allowed to compete. Today, however, women have won gains as equal participants in the Games, as have people with a range of disabilities (e.g., para-athletes and Special Olympics).
## 2.2 Canadian Sport Heroes and Their Achievements

Understanding the historical context of physical activity and sport can deepen your insights into current trends and events. This exercise acquaints you with contributions made by Canadians in the history of sport.

**NAME:** __________________________

**DATE:** __________________________

**MISSION:** Research the major achievements of the following Canadian sport figures, and fill in the table below.

<table>
<thead>
<tr>
<th>Athlete</th>
<th>Major Achievements</th>
</tr>
</thead>
</table>
| James Naismith       | • Invented the game of basketball  
• Wrote the original basketball rulebook  
• Lived to see basketball adopted as an official event at the 1936 Summer Olympics in Berlin                                                                                                         |
| 1891                 |                                                                                                                                                                                                                       |
| Tom Longboat         | • Native Canadian long-distance runner who started the trend of wearing a bathing suit and sneakers while running  
• Won the 1907 Boston Marathon—and broke the record by 5.5 minutes; this record was not beaten until the course was changed to make the race easier  
• In 1909 won the title of “Professional Champion of the World” in a marathon in New York City                                                                                                          |
| 1905–1915            |                                                                                                                                                                                                                       |
| Barbara Ann Scott    | • Known as the “Queen of the Blades”  
• First woman to land a double lutz in a competition (at the age of 13)  
• At the 1947 World Championships, she executed spins, turns, and jumps normally performed by men only  
• Only Canadian woman in Olympic history to win a gold medal in the women's singles event (1948 St. Moritz Games)                                                                                                           |
| 1940s                |                                                                                                                                                                                                                       |
| Abigail Hoffman      | • At the age of 9, cut off her hair and pretended to be a boy in order to play on a boys' hockey team under the name “Ab Hoffman”  
• Won gold in the 800-metre race at the 1963 Pan Am Games; won bronze in the 1967 Games for the 800-metre and silver and bronze for the 1500-metre distances  
• 1981-1991: became first woman Director General of Sport Canada  
• 1982: became an Officer of the Order of Canada  
• 2004: inducted into Canada's Sports Hall of Fame                                                                                                           |
| 1950s–1970s          |                                                                                                                                                                                                                       |
| Dick Pound           | • Swimming competitor at the 1960 Olympic Games—placed sixth in the 100-metre freestyle  
• Swimming competitor at the 1962 Commonwealth Games—attained one gold, two silver, and one bronze  
• President of the Canadian Olympic Committee (1977-1982)  
• First president of the World Anti-Doping Agency (1999-2007)  
• In 2014, appointed chairman of the board of the Olympic Broadcasting Services                                                                                                                                       |
| 1960s                |                                                                                                                                                                                                                       |
| Arnie Boldt          | • Lost his right leg due to a farming accident at the age of 3  
• In 1976 he gained international recognition as a track and field star; he set world records and won gold medals in both the high jump and the long jump at the Olympic for the Disabled (now known as the Paralympic Games)  
• In 1977 and 1978 he won gold at the Canadian Games for the Physically Disabled  
• In 1980 he won gold medals for the long jump and the high jump, and he broke his own world record in the high jump at the Olympic for the Disabled in the Netherlands  
• Competed at top levels of both disabled and able-bodied sport                                                                                                                                                    |
<p>| 1960s–1970s          |                                                                                                                                                                                                                       |</p>
<table>
<thead>
<tr>
<th>Nancy Greene</th>
<th>1960s–1970s</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Canada’s top ski racer throughout the 1960s</td>
<td></td>
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<tr>
<td>• Competed in the 1960, 1964, and 1968 Olympic Games</td>
<td></td>
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<tr>
<td>• Won the 1968 gold medal in the giant slalom at the Grenoble Winter Olympics, and earned a silver medal for her performance in the slalom event</td>
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<tr>
<td>• Her total of 13 World Cup victories is still a Canadian record</td>
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<tr>
<td>• Won 17 Canadian Championship titles in all disciplines</td>
<td></td>
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<tr>
<td>• In 1999, named Canada's female athlete of the century</td>
<td></td>
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<tr>
<td>• Founded the Nancy Greene Ski League, where young Canadians can get their start in ski racing</td>
<td></td>
</tr>
<tr>
<td>• Appointed Senator for British Columbia, Government of Canada, in 2009</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wayne Gretzky</th>
<th>1980s – 1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>• &quot;The Great One&quot;—considered to be the best player in the history of the NHL</td>
<td></td>
</tr>
<tr>
<td>• First “rookie player” to win the Hart Trophy</td>
<td></td>
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<tr>
<td>• Upon his retirement (1999) he held/shared 61 records, and broke nearly all of the records set by Gordie Howe</td>
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</tr>
<tr>
<td>• He is the only NHL player to total over 200 points in one season—four times in his career</td>
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<tr>
<td>• His number (99) has been officially retired by the NHL for all teams</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hayley Wickenheiser</th>
<th>1990s – present</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Member of the Canadian National Women’s Hockey Team</td>
<td></td>
</tr>
<tr>
<td>• First woman to play men’s professional hockey in a position other than goalie, and therefore the first woman to score a goal in a men’s professional league</td>
<td></td>
</tr>
<tr>
<td>• Five-time Olympic medalist (four gold, one silver); has the most gold medals of any Canadian Olympian</td>
<td></td>
</tr>
<tr>
<td>• Participated on the softball team during the 2000 Summer Olympics in Sydney</td>
<td></td>
</tr>
<tr>
<td>• In 2014, elected to the International Olympic Committee’s athlete commission</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chantal Petitclerc</th>
<th>1990s – present</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Competed in both the Winter and Summer Olympic Games</td>
<td></td>
</tr>
<tr>
<td>• In 1995 she won silver in the World Cycling Championships (time trial)</td>
<td></td>
</tr>
<tr>
<td>• Won two bronze medals for cycling in the 1996 Summer Olympic Games</td>
<td></td>
</tr>
<tr>
<td>• Competed in the 1990, 1994, and 2002 Commonwealth Games, and won gold in the time trial, and bronze in the points race on the velodrome</td>
<td></td>
</tr>
<tr>
<td>• Won the bronze medal in the 5,000-metre race at the 2002 Winter Olympic Games</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cindy Klassen</th>
<th>2000 – 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Won the bronze medal in the 3,000-metre speedskating race, and placed fourth in the 1,500-metre and 5,000-metre races at the 2002 Winter Olympics</td>
<td></td>
</tr>
<tr>
<td>• Won a silver medal in the 1,500-metre race and a bronze medal in the 1,000-metre race (with her arm in a splint) at the World Single Distance Championship in 2004</td>
<td></td>
</tr>
<tr>
<td>• In 2004–2005 she won the World Cup title in the 1,500-metre race, and first place finishes in the 1,500-metre and 3,000-metre races at the World Single Distance Championships</td>
<td></td>
</tr>
<tr>
<td>• In the 2006 Winter Olympic Games she won five medals (gold, two silver, two bronze)</td>
<td></td>
</tr>
<tr>
<td>• First Canadian Olympian to win five medals in one Olympic Games and the only Canadian besides Clara Hughes to win a total of six Olympic medals</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alexandre Bilodeau</th>
<th>2006 – 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Won gold in the men’s moguls at the 2010 Winter Olympics in Vancouver, becoming the first Canadian to win a gold medal at an Olympic Games held in Canada</td>
<td></td>
</tr>
<tr>
<td>• At the 2014 Sochi Winter Olympics he became the first Olympian in history to defend his gold medal in any freestyle skiing event (first repeat gold medalist)</td>
<td></td>
</tr>
<tr>
<td>• A three-time FIS World Champion in dual moguls</td>
<td></td>
</tr>
<tr>
<td>• In his final World Cup race in 2014, he retired with a win, and in doing so, surpassed Jean-Luc Brassard for the most World Cup medals won by a Canadian (19 in total)</td>
<td></td>
</tr>
<tr>
<td>• Youngest athlete in history to win a World Cup moguls event (in 2006 at the age of 19)</td>
<td></td>
</tr>
</tbody>
</table>

| [Your own sport hero] | |
|-----------------------| |
WORKSHEET

Chapter 2 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 2. Complete each set of questions according to your teacher's instructions.

Name: ____________________________
Date: _____________________________

Question Set 1: From Ancient Times to the Revival of the Modern Olympics (1896)

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. Which civilization first articulated how physical activity can benefit the mind as well as the body?
   (a) the Aztecs
   (b) the ancient Greeks
   (c) the ancient Romans
   (d) the Europeans of the Renaissance
   ✓ (b) the ancient Greeks

2. Physical education classes for children were instituted in 1420 in Europe by
   (a) Leonardo da Vinci
   (b) Pierre de Coubertin
   (c) Queen Victoria
   ✓ (d) Italian physician Vittorino da Feltre

3. The Victorian gentleman athlete embraced the concept of
   (a) fair play
   (b) amateurism
   (c) sport as a reflection of life
   (d) all of the above
   ✓ (d) all of the above

4. Which cultural group invented lacrosse?
   (a) Early French settlers in the New World
   (b) the Aztecs
   (c) Ancient Greek warriors
   (d) Aboriginal peoples of North America
   ✓ (d) Aboriginal peoples of North America

5. What does the term "Olympic truce" mean?
   (a) offering all athletes have to bring in order to be allowed to compete
   (b) ceremonial clothing worn by early Olympians
   ✓ (c) a global and symbolic agreement aimed at promoting friendly relations between nations
   (d) the prize offered to victorious athletes in early Olympic competition

6. In 2002, the Paralympic Games achieved a major breakthrough in public awareness
   (a) through the efforts of Dr. Robert F. Jackson
   (b) when Canada ranked amongst the top nations
   ✓ (c) when highlights were aired on the A&E cable network in the U.S. and on CBC in Canada
   (d) because the Games were held in Salt Lake City

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. Did Greek and Roman concepts of sport have any effect on each other? If so, what was it?
   When mainland Greece was integrated into the Roman Empire, many Greek sporting ideals were adopted by the Romans.

2. Why was the concept of "athleticism" embraced again during the Renaissance?
   Factors in the revival of interest in the concept of "athleticism" during the Renaissance include renewal of interest in ancient Greek and Roman culture, which glorified athleticism in art; intensified pursuit of scientific knowledge and the study of human anatomy and physiology, thanks to thinkers such as Leonardo da Vinci; and rising interest in physical activity for the sake of personal enjoyment.

3. Why did the Victorians believe that participation in sports was harmful to women?
   Many people, including social leaders, mistakenly believed that a woman's physical constitution was weak and that too much physical exercise would harm a woman's reproductive capabilities.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions:

1. Elaborate on the evolving social significance of sports to Aboriginal peoples in North America.

2. Analyze the relationship between nationalism and sport as demonstrated by the goals of the modern Olympic Games.

3. Explain why the principle of "equal access" to physical activity and sport is an important value in Canadian society.

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**Multiple-Choice Questions**

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Professional sport competition arose when
   (a) amateurism was no longer valued
   ✓ (b) teams started paying their best players to retain them full-time and to motivate them
   (c) Olympic sports became less popular
   (d) the Victorian age was at its height

2. The only fully professional major women's sports league in North America is
   (a) the Women's National Hockey Association
   (b) the Women's National Soccer Association
   ✓ (c) the Women's National Basketball Association
   (d) the Women's National Curling Association

3. The emergence of the modern sports fan began as a result of
   (a) the rise of the Internet
   ✓ (b) industrialization and increased leisure time, including time to read about sports heroes
   (c) the aftermath of the American Civil War
   (d) changing attitudes towards women in sports

4. No women competed in the first modern Olympic Games in 1896 because many people believed that
   (a) women were more athletic than men
   (b) women were too afraid to compete
   ✓ (c) a "woman's place" was in the home
   (d) a "woman's place" was in the factory

5. Sport Canada, the major granting agency for sports in Canada, is located within
   (a) the Athlete Assistance Program
   (b) each provincial and territorial government
   ✓ (c) the Department of Canadian Heritage
   (d) the community of National Games Organizations

6. A driving force behind Canada's evolution into a world-leading sport organization is
   (a) Athletics Canada
   ✓ (b) Own the Podium
   (c) International Amateur Athletics Federation
   (d) Tennis Canada

**Short-Answer Questions**

**MISSION:** Briefly answer the following questions in the space provided:

1. Outline the primary goals of Sport Canada and the Canadian Sport Policy 2012.
   CSP 2012 sets direction for the period 2012-2022 for all governments, institutions, and organizations that are committed to realizing the positive impacts of sport on individuals, communities, and society, e.g., sport excellence; enhanced education and skill development; improved health and wellness; increased civic pride, engagement, and cohesion; increased economic development and prosperity. CSP 2012 impacts the practice and provision of sport in all its forms and contexts, including organized and unorganized, in schools, colleges and universities, parks, and public and private sport centres.

2. What is the main responsibility of the Canadian Olympic Committee?
   All aspects of Canada's involvement in the Olympic Games and the Pan Am Games.

3. Who were the Edmonton Grads and what were the keys to their success?
   The Edmonton Grads won the first women's world title in basketball in 1924. They continue to hold the North American record for the team with the best winning percentage of all time. Their philosophy emphasized the importance of physical conditioning and prohibited any performance-inhibiting activities such as smoking and drinking.

**Essay Questions**

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Explain how the history of women's participation in sport has involved changing societal attitudes and the destruction of stereotypes.

2. Describe how the history of international sport reflects a struggle against exclusionary practices towards various ethnic groups.

3. Describe ways in which the Canadian government and the sport community in Canada promote active, healthy living.
Chapter 3 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 3. Complete each set of questions according to your teacher’s instructions.

Question Set 1: Sport as a Business Enterprise

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Amateur athletes receive compensation for their efforts through
   (a) player contracts
   (b) endorsement deals
   (c) sale of merchandise and tickets
   ✔ (d) none of the above

2. Formerly for amateurs only, the Olympic Games now permit competition by professional
   (a) skaters and ice dancers
   ✔ (b) hockey and basketball players
   (c) baseball and softball players
   (d) boxers and wrestlers

3. The largest source of profits for big-business sports teams is
   (a) athlete endorsements
   (b) ticket sales
   ✔ (c) the use of games for the sale of various rights
   (d) concession sales

4. Many sports events are broadcast as
   (a) regular over-the-air telecasts
   (b) exclusive pay-per-view engagements
   (c) live-streamed video
   ✔ (d) all of the above

5. Nike has received criticism for
   (a) the huge endorsement fees it has paid to celebrity athletes
   (b) the targeting of its marketing towards youth
   ✔ (c) the manufacturing of its products in Third World countries
   (d) its advertising at the London Olympic Games

6. Professional sports teams contribute to their local economy by
   (a) increasing sales at restaurants and hotels close to stadiums
   (b) employing people in the local community
   (c) paying taxes to the government
   ✔ (d) all of the above

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. The revenue generation associated with live sports events is similar to what other events?
   Concerts, films, craft fairs, and trade shows.

2. What features are offered to viewers as part of an overall sport-as-entertainment package?
   Play-by-play announcers, pre- and post-game analysis, interviews, highlights, replays, in-depth player profiles.

3. Which trend in athlete endorsement and marketing was ushered in by Michael Jordan’s huge endorsement contract?
   Players who earn more from endorsements than from their sport salaries.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Does a city actually benefit from hosting the Olympic Games, thereby justifying the enormous cost of preparing a bid for the IOC?

2. How do broadcasters recoup the massive sums they have paid for broadcasting rights to sporting events? What would happen if this revenue source were unavailable to them?

3. Examine arguments both for and against the role of a player’s agent. Form your own opinion and provide justification for it.
Question Set 2: Sport Media and the Sport Consumer

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Technical advances in television broadcasting have led to the growth of
   (a) mobile platforms for sports events
   (b) the sport-as-entertainment industry
   (c) professional sports leagues
   (d) the fitness industry
   ✔ (b) the sport-as-entertainment industry

2. The primary relationship between professional sports teams and leagues and the media is the
   (a) overall entertainment package offered to fans
   (b) viewing of games via mobile devices
   (c) blending of sports action and advertising
   (d) sales of broadcasting rights to games
   ✔ (d) sales of broadcasting rights to games

3. A major threat for sports broadcasting companies is
   (a) the piracy of broadcast signals
   (b) Canada's federal Competition Bureau
   (c) increasing bandwidth fees
   (d) mergers between telecommunications giants
   ✔ (a) the piracy of broadcast signals

4. Sports fans today use social media
   (a) to receive and share scores and statistics
   (b) to follow live action or catch highlights on their computers or mobile phones
   (c) to engage in direct social exchanges with their favourite athletes
   (d) all of the above
   ✔ (d) all of the above

5. We can protect ourselves from fraudulent claims made about health and wellness products by
   (a) asking friends for their opinions
   (b) buying only small samples to see if they work
   (c) relying on reliable sources of information such as Health Canada
   (d) checking out online testimonials
   ✔ (c) relying on reliable sources of information such as Health Canada

6. Membership contracts with pre-payment, facility-based businesses such as fitness clubs are called
   (a) renewable-option agreements
   (b) consumer alert agreements
   (c) personal development services agreements
   (d) criteria-based agreements
   ✔ (c) personal development services agreements

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. Why might it be a problem if too much sports broadcasting power is placed in the hands of just a few people? These people might exploit the situation by charging higher and higher fees for their sports media content.

2. What are three factors fuelling increasing sales of products and services related to health and fitness?
   (1) An aging population, (2) high obesity levels, and (3) raised awareness of the detrimental effects of consuming unhealthy foods.

3. List three target markets that are especially susceptible to false or misleading advertising related to health and wellness products and services.
   (1) Seniors, (2) overweight teens and adults, and (3) children "hooked" on video games.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. What are the advantages and disadvantages when a company purchasing a sports team or franchise owns media outlets as well?

2. Various forms of social media have changed how fans follow sports. Are these trends positive or negative? Justify your opinion.

3. How can you become sufficiently well-informed when deciding to purchase a health product or sign up for a gym or a fitness club?
4.1 Gender-Based Pay Inequity in Sport

Male and female athletes today have many opportunities to experience success. However, women still face disadvantages when it comes to levels of participation, financial compensation, and endorsement deals.

Name: ____________________________
Date: ____________________________

MISSION: Do some research and then complete the chart below to show the differences in financial compensation in six sport leagues and events for pro male athletes versus pro female athletes.

<table>
<thead>
<tr>
<th>Sport</th>
<th>Average Annual Salaries</th>
<th>Event Prize Money</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Basketball</td>
<td>NBA</td>
<td>WNBA</td>
</tr>
<tr>
<td></td>
<td>Average: $5 million</td>
<td>Average: $72,000</td>
</tr>
<tr>
<td>Hockey</td>
<td>NHL: $14 million</td>
<td>CWHL: No salary (endorsements only)</td>
</tr>
<tr>
<td>Golf</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Horse racing (jockey earnings)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Nascar racing</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Tennis (Grand Slam)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Tennis (Canadian)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
MISSION: After completing your research, answer the questions below. For each question, state your opinion or make suggestions, and then provide a rationale.

Do you think that pay equity for male and female athletes is good for sport in general? Why or why not?

Possible answers: Yes, because equity in salaries can lead to heightened status for women in sport and positive role modelling on the part of female athletes, plus increased opportunities for success in careers in sport and overall success for women. No, not really, because there are different levels of participation and interest in men's sport vs. women's sport.

1. Should the media bear some responsibility to promote pay equity for men and women in professional-level sport?

Answers could relate to the concept of supply and demand. Increased promotion of women's sport by the media could lead to increased interest in both men's and women's sports, as seen in tennis, where prize money for men and women is now equal.

2. What measures might (a) the Canadian federal government and (b) private corporations take to promote gender-based pay equity in Canadian sport?

(a) The Canadian government is obliged to support all citizens equally under its Charter of Rights and Freedoms, so it should provide equal funding to male and female athletes through its various Sport Canada programs, etc. (b) Private corporations that value equity in the workplace should also support equity in sport by sponsoring women’s sporting events to the same extent that they sponsor men’s events, thus enhancing the profile of women’s sport and ensuring pay equity for female athletes.

3. Would pay equity have a positive overall impact on gender equality in a sport? Might pay equity in the world of sport have a positive influence on gender equality in society as a whole? Explain your thinking.

Yes, perhaps, but pay equity is only one aspect of sport-related equity issues—there is need for equal funding for facilities, coaching, marketing of women's sports, etc. Yes, if female athletes were treated equally in all regards, this would create a positive model for the treatment of women in society in general.
4.3 True Sport—What Constitutes “Fair Play”?  

Understanding the origin of the True Sport Movement can further your appreciation of current trends and events related to ethical conduct in sport, and of how fair play principles apply in everyday situations.

Name: ____________________________  
Date: ____________________________

Championing “Fair Play” in Sport in Canada

The concept of “fair play” is important not only in sporting situations, but in society as a whole. With this in mind, federal and provincial government leaders from across Canada met in 2001 to discuss some controversial issues that had arisen in sport.

These leaders recognized the positive impact that fair play practices in sport can have in our communities, and they sought to find a way to reduce the incidence of violence, bullying, cheating, aggressive parental behaviour, and doping in relationship to sport.

Their discussions led to the signing of the London Declaration in 2001. This Declaration was described as “an unprecedented affirmation of positive sporting values and principles.”

The Canadian Centre for Ethics in Sport (CCES) then led a series of discussions across Canada to identify how to help young athletes stay on an ethical path. In the early 2000s, the CCES helped to form True Sport.

True Sport is a series of programs and initiatives that are centered upon four shared values and principles: fairness, excellence, inclusion, and fun. Schools, communities, and organizations can tap into these programs and initiatives to help promote the many positive benefits that play and sport can provide.

True Sport believes that good sport can make a profound difference in our athletes and in our communities, and thus they promote the following seven True Sport Principles.

The Seven True Sport Principles

1. Keep it fun. Find the joy of sport and have a good time. Keep a positive attitude and look to make a positive difference, on the field and in your community.

2. Respect others. Show respect for everyone in creating a sporting experience, both on the field and off. Win with dignity and lose with grace.

3. Give back. Always remember the community that supports your sport and helps make it possible. Find ways to show your appreciation and help others get the most out of sport.

4. Go for it. Always strive for excellence and rise to the challenge, but never at the expense of others. Discover how good you can be.

5. Play fair. Play honestly and obey the rules in letter and spirit. Winning is only meaningful when competition is fair.

6. Stay healthy. Place physical and mental health above all other considerations and avoid unsafe activities. Respect your body and keep in shape.

7. Include everyone. Share sport with others, regardless of creed, ethnicity, gender, sexual orientation or ability. Invite everyone into sport to make it more meaningful for the whole community.
Applying the Seven True Sport Principles

MISSION: Apply the seven True Sport Principles to help you evaluate and respond to the dilemmas outlined in the scenarios below. Identify the specific True Sport Principle(s) that pertain to each scenario.

Scenario 1: You are helping out as a leader with a house league hockey team. The team is made up of boys and girls who are seven years old. You notice that the coach only chooses a few of the more talented boys to demonstrate drills. Explain how you would react to the coach’s behaviour, and why.

Scenario 1:
True Sport Principle #7: Include everyone. Point out to the coach that in order to honour this important principle, all athletes should have an opportunity to participate in and benefit from demonstrations.

Scenario 2: Your school’s dance team has worked extremely hard over the past three years. The team members have developed outstanding skills and abilities. As a result, they have won all of the competitions they entered in the past year. If you were the coach, what more could you do to challenge your team?

Scenario 2:
True Sport Principle #3. Give back. You and your team could stage a free dance performance and invite the whole community to attend, or stage a performance to raise funds for a local or global cause.

Scenario 3: You are a member of your school’s football team. Two students from your school have the job of holding the first-down measuring chain (which marks the distance to the first down). During a league game, you notice that the students who are holding the measuring chain have been moving the flag too far, thus giving your team an unfair advantage when you are on offence. Explain how you would react to this situation, and why.

Scenario 3:
True Sport Principle #5: Play fair. Moving the flag too far to give your team an unfair advantage is cheating.
Coaches and officials should be notified of the problem through pre-arranged communication channels.

Scenario 4: You are a pitcher for a rep softball team. You are enjoying an excellent game, pitching a no-hitter as you head towards the final inning. There are two outs and the potential last batter is at the plate. The batter connects with your pitch and sprints to first base. It appears that the runner is just barely thrown out at first, when the umpire calls her safe. Explain how you would react to the umpire’s call, and why.

Scenario 4:
True Sport Principle #2: Respect others. The umpire’s call may be erroneous, but you must react to it respectfully.
You can submit an appeal of the call in a respectful fashion following the proper protocol.

Scenario 5: Your friend is training hard for an upcoming track-and-field meet. She is experiencing a lot of anxiety about the outcome of the competition. She feels intense pressure to win for the glory of her team and her school, so much so that she confides to you that she is on the verge of taking a banned performance-enhancing substance. Which True Sport principle(s) would your friend violate if she resorts to using a banned performance-boosting substance? What advice would you give your friend?

Scenario 5:
True Sport Principle #6: Stay healthy. Advise your friend to focus on doing her best and to be confident in her abilities rather than resorting to a banned substance, which could pose risks to her health. Point out to your friend that winning at all costs is not winning at all.
Chapter 4 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 4. Complete each set of questions according to your teacher's instructions.

Question Set 1: Sport Equity and the Ethics of Advertising and Sponsorship

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Examples of gender-based inequity in sport include
   (a) prohibition of women from competing in high-profile men's professional events
   (b) lower pay for women in professional sports leagues compared to pay for men
   (c) fewer opportunities for corporate sponsorship for female athletes compared to male athletes
   ✓ (d) all of the above

2. One major sport in which men and women are compensated equally is:
   (a) basketball
   (b) race car driving
   (c) wrestling
   ✓ (d) tennis

3. According to CAAWS, gender equity in sport requires
   ✓ (a) equal access for girls and women to a full range of sport activity and program choices
   (b) identical sport programs for both sexes
   (c) "feminine" sport activity and program choices
   (d) women's participation in "male" sports

4. The first male participant in a major professional sport to come out as gay was
   (a) Mark Tewksbury
   (b) Michael Sam
   ✓ (c) Jason Collins
   (d) Greg Louganis

5. Advocates of tighter regulation of sport sponsorship by the alcohol industry liken alcohol to
   (a) cocaine
   ✓ (b) tobacco
   (c) sugar
   (d) heroin

6. The backlash against soft drink manufacturers has not been as strong as it has been against
   (a) fast food outlets
   (b) manufacturers of processed foods
   ✓ (c) manufacturers of cigarettes and alcohol
   (d) manufacturers of energy drinks

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided.

1. What is the general result of gender-based inequities in sport and in society as a whole?
   A power imbalance between groups that can lead to exploitation of the weaker group by the more powerful group.

2. Who is one notable exception to the general trend of male referees officiating at men's professional sporting events?
   NBA and WNBA referee Violet Palmer.

3. Why do many observers consider gender tests administered by the IAAF to be flawed?
   These tests fail to take into account people who are intersexed (i.e., have a male genetic make-up and female anatomy or body chemistry, or vice versa). Also, many scientists believe that looking at the amount of testosterone in an athlete's body is not a fair way to determine gender.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Discuss what can be done to combat gender-based inequities in sport such as pay disparity and under-representation of women as coaches and referees.

2. Discuss ways to confront discrimination based on sexual orientation in the world of sport.

3. Analyze the prevalence of sexist and offensive advertising during televised sports events.
Question Set 2: Violence, Cheating, and the Fair Play Movement

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Some experts claim that helmets worn by sports players cannot completely eliminate
   (a) body checking
   (b) neck injuries
   (c) spinal cord injuries
   ✔ (d) serious brain injury

2. The world soccer organization FIFA has penalized unruly soccer fans by
   (a) fining soccer teams
   (b) banning teams from competition
   (c) forcing teams to play games in empty stadiums
   ✔ (d) all of the above

3. If a serious injury prevents movements of a person's arms and legs, the injury is known as
   (a) paraplegia
   ✔ (b) quadriplegia
   (c) neuralgia
   (d) post-concussion syndrome

4. A sports player who suffers a concussion should
   (a) report it immediately to a trainer or coach
   (b) consult a doctor right away
   (c) focus on recovery so the brain has time to heal
   ✔ (d) all of the above

5. Collaboration among professional sports team owners, players, and referees to predetermine the results of a game is known as
   (a) "working the ref"
   (b) "influence peddling"
   ✔ (c) "match fixing"
   (d) "bending the rules"

6. The four core values of the True Sport Movement are
   ✔ (a) fairness, excellence, inclusion, and fun
   (b) respect, equity, dignity, and ethical conduct
   (c) friendship, team spirit, fair competition, sport without doping
   (d) tolerance, care, excellence, and the joy of movement

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. List various methods that athletes use to cheat.
   Influencing the decisions of match officials; using illegal or banned substances; using illegal equipment; match fixing.

2. What does it mean if a coach urges a team player to "hit hard but hit legal"?
   Make bodily contact with an opponent as long as that contact stays within the rules of the sport.

3. Why is the role of youth-sport coaches in furthering the principles of fair play more important than ever?
   The prevalence of bullying in schools and communities across Canada as well as the prevalence of overly aggressive "sports parents" who abuse sports coaches and officials verbally and physically make the principles of fair play more important than ever.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Discuss the issue of dangerous levels of violence and aggression in major team sports.

2. Examine the possible ethical risks if a coach promotes the attitude of "winning at all costs."

3. Explain the mandate of the Canadian Centre for Ethics in Sport.
5.1 Anatomical Terminology

The "anatomical position" is the universally accepted starting point for anatomical description and analysis. Along with "planes" and "axes," this is a fundamental concept that should be grasped before moving on.

(A) The Anatomical Position

MISSION:
Label the visual using the labels provided below.

- Midline
- Posterior/anterior
- Distal/proximal
- superior/inferior
- medial/lateral

In your own words, list the main "points to remember" about the anatomical position, as described on page 118 your textbook. The main bodily orientations of the anatomical position are:

1. The person is in an upright, standing position.

2. The head, eyes, and toes are pointing forward.

3. The feet are together.

4. The arms are slightly out to the side.

5. The forearms are fully supinated (the palms of the hands are facing forward).
(B) Anatomical Planes and Anatomical Axes

**MISSION:** Anatomical planes and anatomical axes are at right angles to each other. Label the planes and axes and then lightly colourize the planes in the illustration below. Commit them to memory to the point where you can use these terms freely to describe any movement.

- Antero-posterior axis
- Horizontal axis
- Longitudinal axis
- Sagittal plane
- Frontal Plane
- Transverse Plane

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(C) Describing Movements at Joints

Now that you have a grasp of the basic concepts (anatomical position and planes and axes), here are a few more anatomical terms that derive from these concepts and that are commonly used to describe movement.

**MISSION:** Label the movements below choosing the correct terms:

- Dorsiflexion / Plantar flexion
- Eversion / Inversion
- Pronation / Supination
- Flexion / Extension
- External rotation / Internal rotation
- Abduction / Adduction
- Circumduction

![Diagram of movements](image-url)
**Which Anatomical Term is Correct?**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Straightening cut your leg at the knee is an example of [extension / flexion].</td>
<td>extension</td>
</tr>
<tr>
<td>2.</td>
<td>A biceps curl is an example of arm [flexion / extension] at the elbow.</td>
<td>flexion</td>
</tr>
<tr>
<td>3.</td>
<td>Unscrewing a bottle with your right hand is in example of [pronation / supination] at the wrist.</td>
<td>supination</td>
</tr>
<tr>
<td>4.</td>
<td>Standing on your tiptoes is an example of [plantar flexion / dorsiflexion] at the ankle.</td>
<td>plantar flexion</td>
</tr>
<tr>
<td>5.</td>
<td>Bringing your arm in towards your sides is an example of [adduction / abduction].</td>
<td>adduction</td>
</tr>
<tr>
<td>6.</td>
<td>Throwing an underhand softball pitch is an example of [extension / circumduction] at the shoulder.</td>
<td>circumduction</td>
</tr>
<tr>
<td>7.</td>
<td>Most common ankle injuries involved either [eversion / inversion] at the ankle joint.</td>
<td>inversion</td>
</tr>
<tr>
<td>8.</td>
<td>Shrugging to indicate a &quot;no&quot; response is an example of [depression / elevation] of the shoulders.</td>
<td>elevation</td>
</tr>
<tr>
<td>9.</td>
<td>The axis of rotation is always [perpendicular / parallel] to the plane of movement.</td>
<td>perpendicular</td>
</tr>
<tr>
<td>10.</td>
<td>The quadriceps muscles are located on the [anterior / posterior] side of the thigh.</td>
<td>anterior</td>
</tr>
<tr>
<td>11.</td>
<td>The heart is [inferior / superior] to the diaphragm muscle.</td>
<td>superior</td>
</tr>
<tr>
<td>12.</td>
<td>The elbow joint is at the [proximal / distal] end of the humerus.</td>
<td>distal</td>
</tr>
<tr>
<td>13.</td>
<td>The shoulder joint is at the [proximal / distal] end of the humerus.</td>
<td>proximal</td>
</tr>
<tr>
<td>14.</td>
<td>Tennis elbow (a tendon injury on the outer side at the elbow) involves an injury to the [lateral / medial] epicondyle.</td>
<td>lateral</td>
</tr>
<tr>
<td>15.</td>
<td>A figure skater in a spinning movement is rotating on the [antero-posterior / longitudinal] axis.</td>
<td>longitudinal</td>
</tr>
<tr>
<td>16.</td>
<td>A figure skater in a spinning movement is rotating on the [transverse / sagittal] plane.</td>
<td>transverse</td>
</tr>
<tr>
<td>17.</td>
<td>A forward tumble by a gymnast involves rotation on the [horizontal / longitudinal] axis.</td>
<td>horizontal</td>
</tr>
<tr>
<td>18.</td>
<td>A forward tumble by a gymnast involves rotation on the [frontal / sagittal] plane.</td>
<td>sagittal</td>
</tr>
<tr>
<td>19.</td>
<td>A sideways cartwheel involves rotation on the [antero-posterior / horizontal] axis.</td>
<td>antero-posterior</td>
</tr>
<tr>
<td>20.</td>
<td>A sideways cartwheel involves rotation on the [frontal / transverse] plane.</td>
<td>frontal</td>
</tr>
</tbody>
</table>
5.2 Major Bones in the Human Body

There are about 209 bones in the human skeleton. Many of the major ones are shown in the illustrations on these two pages.

**Mission:** Find the major bones listed below. Write their name beside the correct number below.

**Labels (Posterior View)**

- Calcaneus
- Cervical Spine (C1-C7)
- Coccyx
- Femur
- Fibula
- Humerus
- Ilium
- Lumbar (L1-L5)
- Occipital Bone
- Parietal Bones
- Sacrum
- Sagittal Suture
- Scapula
- Thoracic Spine (T1-T12)
- Tibia

1. Sagittal Suture
2. Cervical Spine (C1-C7)
3. Thoracic Spine (T1-T12)
4. Lumbar (L1-L5)
5. Sacrum
6. Parietal Bones
7. Occipital Bone
8. Scapula
9. Humerus
10. Ilium
11. Coccyx
12. Femur
13. Tibia
14. Fibula
15. Calcaneus
Labels (Anterior View)

- 12 Ribs
  (7 True; 3 False; 2 Floating)
- Carpals
- Clavicle
- Costal Cartilage
- Femur
- Fibula
- Frontal Bone
- Humerus
- Ilium
- Mandible
- Manubrium
- Metatarsals
- Maxilla
- Metacarpals
- Patella
- Phalanges (digits) [x2]
- Radius
- Sacrum
- Sternum
- Symphysis Pubis
- Talus
- Temporal Bone
- Tibia
- Ulna
- Xiphoid Process
- Zygomatic Bone

1. Frontal Bone
2. Temporal Bone
3. Zygomatic Bone
4. Xiphoid Process
5. 12 Ribs (7 True; 3 False; 2 Floating)
6. Sacrum
7. Carpals
8. Metacarpals
9. Phalanges (digits)
10. Fibula
11. Tibia
12. Maxilla
13. Mandible
14. Clavicle
15. Manubrium
16. Sternum
17. Costal Cartilage
18. Humerus
19. Radius
20. Ilium
21. Ulna
22. Symphysis Pubis
23. Femur
24. Patella
25. Talus
26. Metatarsals
27. Phalanges (digits)

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Chapter 5. The Skeletal and Articular Systems
5.3 The Anatomy of a Long Bone

The long bone is the most familiar of the five basic bone types. Examples of long bones are the femur, the fibula, and the tibia.

MISSION: Label the illustration below (some labels may be used twice) using the terms on the left-hand side.

Name: __________________________
Date: _________________________

Labels

☐ Cartilage
☐ Cancellous bone
☐ Compact bone
☐ Diaphysis
☐ Epiphyseal line
☐ Epiphyseal plate
☐ Epiphysis
☐ Medullary cavity
☐ Periosteum

Diaphysis

Epiphysis

Cancellous bone

Compact bone

Medullary cavity

Periosteum

Epiphyseal plate

Cartilage

Epiphyseal line
5.4 Bones and Bone Landmarks

The specific locations at which major muscles, ligaments, or other connective tissue attach to bone are known as “landmarks.”

**MISSION:** Label the illustrations on pages 69-79. Some labels may need to be used more than once.

**Labels**

- External auditory meatus
- Frontal bone
- Mandible
- Mastoid process
- Maxilla
- Nasal bone
- Nuchal line
- Occipital bone
- Parietal bone
- Temporal bone
- Zygomatic bone

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Chapter 5. The Skeletal and Articular Systems
Thoracic cage, anterior and posterior views.

- Body
- Clavicle
- First thoracic vertebra
- Manubrium
- Scapula
- Seven true ribs
- Sternum
- Three false ribs
- Two floating ribs
- Xiphoid process

First thoracic vertebra
Manubrium
Body
Sternum
Xiphoid process

Seven true ribs
Three false ribs
Two floating ribs
Clavicle
Scapula
Left scapula (top), posterior view; left scapula (bottom left), lateral view; left scapula (bottom right), anterior view.

- Acromion process
- Coracoid process
- Glenoid cavity
- Glenoid fossa
- Inferior angle
- Infraglenoid tubercle
- Infraspinous fossa
- Lateral border
- Medial border
- Scapular notch
- Scapular spine
- Subscapular fossa
- Superior angle
- Supraglenoid tubercle
- Supraspinous fossa
Left humerus, anterior and posterior views.

- **Capitulum**
- **Coronoid fossa**
- **Deltoid tuberosity**
- **Greater tubercle**
- **Head**

- **Intertubercular (bicipital groove)**
- **Lateral epicondyle**
- **Lesser tubercle**
- **Medial epicondyle**

- **Olecranon fossa**
- **Radial fossa**
- **Shaft**
- **Trochlea**
Labels:
- Coronoid process
- Head
- Olecranon
- Olecranon process
- Radial notch of ulna
- Radial tuberosity
- Radius
- Styloid process of radius
- Styloid process of ulna
- Trochlear (semilunar) notch
- Ulna
- Ulna tuberosity

Left ulna and radius, anterior view.
Pelvis (male), anterior and posterior views.

- Acetabulum
- Anterior inferior iliac spine
- Anterior superior iliac spine
- Coccyx
- Crest of ilium
- Fifth lumbar vertebra
- Ilium
- Inferior ramis of pubis
- Ischial spine
- Ischial tuberosity
- Ischium
- Obturator foramen
- Os coxae
- Posterior superior iliac spine
- Pubis
- Sacroiliac joint
- Sacrum
- Superior ramis of pubis
- Symphysis pubis
- Posterior inferior iliac spine

Sacrum

Sacroiliac joint

Anterior superior iliac spine

Anterior inferior iliac spine

Acetabulum

Obturator foramen

Symphysis pubis

Inferior ramis of pubis

Fifth lumbar vertebra

Coccyx

Pubis

Os coxae

Ischium

Superior ramis of pubis

Sacrum

Posterior superior iliac spine

Posterior inferior iliac spine

Ischial spine

Ischial tuberosity
Right femur, anterior and posterior views.

Labels:
- Adductor tubercle
- Gluteal tuberosity
- Greater trochanter
- Head
- Intercondylar fossa
- Intertrochanteric crest
- Intertrochanteric line
- Lateral condyle
- Lateral epicondyle
- Lesser trochanter
- Linea aspera
- Medial condyle
- Medial epicondyle
- Neck
- Patellar groove
- Pectineal line
- Shaft

Diagram notes:
- Head
- Neck
- Greater trochanter
- Intertrochanteric crest
- Lesser trochanter
- Gluteal tuberosity
- Pectineal line
- Linea aspera
- Shaft
- Adductor tubercle
- Lateral epicondyle
- Medial epicondyle
- Lateral condyle
- Intercondylar fossa
- Median condyle
- Medial epicondyle

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Right fibula and tibia, anterior view; and tibial plateau, superior view.
5.6 The Characteristics of a Synovial Joint

Synovial joints are one of the three major types of joints in the human body. They permit movement between two or more bones.

**MISSION:** To gain familiarity with the main aspects of the synovial joint, label the illustration below.

---

**Labels**

- Articular cartilage
- Blood vessel
- Bone
- Bursa
- Joint capsule
- Joint cavity (filled with synovial fluid)
- Nerve
- Synovial membrane
- Tendon

---

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### 5.7 Constructing a Model of a Synovial Joint

**Synovial joints are comprised of:** cartilage, the joint capsule, synovia, the joint cavity, the bursae, and ligaments (intrinsic and extrinsic).

**MISSION:** List the components needed to construct a movable joint (the joint must be able to articulate).

---

**ADDITIONAL PLANNING SHEET: Student responses will vary.**

<table>
<thead>
<tr>
<th>Name(s) of team members</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of joint (your choice)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Due date and timelines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g., Internet, visit physiotherapy clinic, etc.)</td>
</tr>
</tbody>
</table>

---

### Materials Required to Construct the Joint

<table>
<thead>
<tr>
<th>Bones and joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g., wooden dowels; paper towel rolls; tennis balls; hinges; pipes; plumbing couplings)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cartilage</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g., concave plastic from a water bottle; modelling clay; plasticene)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ligaments</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g., Velcro; pipe cleaners; plastic ties)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tendons</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g., rubber bands; wire; string)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e.g., partially inflated balloons filled with flour)</td>
</tr>
</tbody>
</table>
5.8 The Shoulder and Knee Joints

Because of their size and composition, the shoulders and knees are key joints in the human body. They are complex structures. This exercise will help you understand how they help us move about.

MISSION: Label the main components of the shoulder joint illustrated below, as well as the four anatomical views of the knee joint on the following pages. Some labels may need to be used more than once.

Labels

- Acromioclavicular ligament
- Acromion
- Clavicle
- Coracoacromial ligament
- Coracoclavicular ligament
- Coracoid process
- Glenohumeral ligaments and joint capsule
- Humerus
- Scapula
- Tendon of biceps brachii (long head)

Left shoulder joint, anterior view.
Right knee, anterior and anterior deep views.

Labels

- Anterior cruciate ligament
- Femur
- Fibula
- Lateral (fibular) collateral ligament removed
- Lateral condyle
- Lateral meniscus
- Medial condyle
- Medial (tibial) collateral ligament
- Medial (tibial) collateral ligament removed
- Medial meniscus
- Patella (wrapped within a tendon—sesamoid bone)
- Patellar ligament
- Posterior cruciate ligament
- Quadriceps tendon (patellar tendon)
- Tibia
- Tibial tuberosity
5.9 Describing Movements at Joints

Joints and the surrounding muscles can be strengthened using different types of exercises. You may wish to complete this exercise after you have learned about the human muscular system in Chapter 6.

**MISSION**: In the worksheet below, indicate which are the main muscles in use, the joints involved, and the type of movement that is produced. A sample entry is provided below.

<table>
<thead>
<tr>
<th>Exercises</th>
<th>Major Muscles</th>
<th>Joints Involved</th>
<th>Movement Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench press</td>
<td>pectoralis major, anterior deltoit, and triceps brachii</td>
<td>elbow and shoulder</td>
<td>elbow extension and medial shoulder rotation and flexion</td>
</tr>
<tr>
<td>Dumbbell flies</td>
<td>pectoralis major, anterior deltoit, and triceps brachii</td>
<td>elbow and shoulder</td>
<td>scapula protraction, medial shoulder rotation and flexion</td>
</tr>
<tr>
<td>Front lat pull-downs</td>
<td>latissimus dorsi, biceps brachii, posterior deltoit, and hand and wrist flexors</td>
<td>elbow and shoulder</td>
<td>elbow flexion and adduction</td>
</tr>
<tr>
<td>(not behind head)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder press</td>
<td>deltoids and triceps brachii</td>
<td>shoulder and elbow</td>
<td>elbow extension and abduction</td>
</tr>
<tr>
<td>Leg curls</td>
<td>hamstrings group and gastrocnemius</td>
<td>knee</td>
<td>knee flexion</td>
</tr>
<tr>
<td>Squats</td>
<td>quadriceps group, gluteus maximus, hamstrings, and erector spinae</td>
<td>hip, knee, and ankle</td>
<td>knee extension and hip extension</td>
</tr>
<tr>
<td>Front plank</td>
<td>rectus abdominis, erector spinae, deltoits, latissimus dorsi, quadriceps, hamstrings, gastrocnemius, gluteals</td>
<td>hips, knees, ankles, shoulders</td>
<td>[Isometric contractions]</td>
</tr>
<tr>
<td>Shoulder shrug</td>
<td>trapezius and levator scapulae</td>
<td>shoulder</td>
<td>shoulder extension</td>
</tr>
<tr>
<td>Triceps extension</td>
<td>triceps brachii, deltoids, and latissimus dorsi</td>
<td>elbow</td>
<td>elbow extension</td>
</tr>
<tr>
<td>Push-ups</td>
<td>pectoralis major, triceps brachii, rectus abdominis, deltoits, and external obliques</td>
<td>elbow, shoulder, wrist, and ankles</td>
<td>elbow extension, shoulder protraction, and dorsiflexion</td>
</tr>
<tr>
<td>McGill crunches</td>
<td>rectus abdominus and external obliques</td>
<td>spine</td>
<td>trunk flexion</td>
</tr>
<tr>
<td>Power clean</td>
<td>quadriceps group, gluteus, hamstrings, erector spinae group, biceps brachii, deltoits, and trapezius</td>
<td>knee, hip, elbow, and shoulder</td>
<td>knee extension, hip extension, elbow flexion, elbow extension, and arm abduction</td>
</tr>
<tr>
<td>Arm curls</td>
<td>biceps brachii</td>
<td>elbow</td>
<td>elbow flexion</td>
</tr>
</tbody>
</table>

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Chapter 5 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 5. Complete each set of questions according to your teacher's instructions.

**Question Set 1: Anatomical Terminology and the Human Skeletal System**

**Multiple-Choice Questions**

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. The standard starting point for human anatomical description and analysis is
   (a) the axial and appendicular skeleton
   (b) anatomical planes and axes
   ✓ (c) the anatomical position
   (d) the long bone

2. As opposed to the axial skeleton, the appendicular skeleton
   (a) is the division of the skeleton from which all muscles originate
   (b) features the sternum as its central aspect
   ✓ (c) can only be seen from the anterior view
   ✓ (d) includes the limbs and plays a key role in allowing us to move

3. The nutrients and blood in bones are found in the
   (a) periosteum
   (b) diaphysis
   (c) articulating cartilage
   ✓ (d) bone marrow

4. Tendons usually unite and attach to the
   ✓ (a) periosteum
   (b) diaphysis
   (c) articulating cartilage
   (d) bone marrow

5. The structure found on the ends of long bones is the
   (a) periosteum
   (b) diaphysis
   ✓ (c) articulating cartilage
   (d) bone marrow

6. Bones attach to other bones across joints by means of
   (a) tendons
   (b) cartilage
   ✓ (c) ligaments
   (d) muscle

**Short-Answer Questions**

**MISSION:** Briefly answer the following questions in the space provided:

1. List the five main functions of the skeletal system.
   (1) Structural support, (2) protection of organs, (3) red blood cell and platelet formation, (4) mineral storage, (5) framework for movement.

2. Name the five types of bones and give an example of each type.
   (1) Flat: parietal bone; (2) irregular: vertebra; (3) sesamoid: patella; (4) short: carpal; (5) long: femur.

3. What is meant by a bone “landmark”? A landmark is a feature of a bone such as a ridge, bump, groove, depression, or prominence that serves as a guide to the location of other body structures.

**Essay Questions**

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Long bones play a major role in our bodily movements. Sketch and describe the main components and features of a long bone.

2. What are some habits and behaviours that can help us to maintain and strengthen our skeletal system as we age?

3. What is the difference between osteoarthritis and osteoporosis? Who is particularly vulnerable to the condition known as osteoporosis? Explain why.
Question Set 2: Joints and Joint-Related Injuries

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Which of the following best describes a synovial joint?
   - (a) articulating cartilage located on the ends of the bones that come in contact protects them
   - (b) features a joint cavity filled with synovial fluid
   - (c) permits movement between two or more bones
   - (d) all of the above
   ✔ (d) all of the above

2. Which of the following synovial joints is a ball-and-socket joint?
   - (a) knee joint
   - (b) metatarsal joints
   - (c) hip joint
   - (d) radioulnar joint
   ✔ (c) hip joint

3. Which of the following joints is classified as uni-axial?
   - (a) shoulder joint
   - (b) elbow joint
   - (c) carpal joints
   - (d) thumb joint
   ✔ (b) elbow joint

4. Thick bands of fibrous connective tissue that help reinforce the joint and joint capsule are called
   - (a) bursae
   - (b) ligaments
   - (c) tendons
   - (d) cartilage
   ✔ (b) ligaments

5. Which of the following bone(s) make up the shoulder joint?
   - (a) clavicle
   - (b) scapula
   - (c) humerus
   - (d) all of the above
   ✔ (d) all of the above

6. Which of the following muscles help to stabilize the knee joint on the anterior side?
   - (a) hamstrings
   - (b) quadriceps
   - (c) gastrocnemius
   - (d) gluteus maximus
   ✔ (b) quadriceps

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. Joints are classified by structure and by function. Name the three types of joints, giving an example of each type.
   - Fibrous—skull; cartilaginous—intervertebral discs; synovial—knee

2. The synovial joint is the most common joint in the human body. What are the six different types of synovial joints?
   - Ball-and-socket; gliding; hinge; pivot; saddle; and ellipsoid

3. Distinguish the difference between first-, second-, and third-degree tears, sprains, and pulls.
   - First—mild; second—moderate; third—severe

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. The synovial joint is the type of joint closely associated with human movement. Sketch and describe its main features.

2. List at least five common joint-related injuries and describe the proper treatment for an injury to a joint.

3. Summarize which type of activities or sports tend to cause injury to the shoulder and ankle joints, and explain the nature of these injuries and why they occur frequently.
6.1 Major Muscles of the Human Body

Skeletal muscles are those that are attached to bones (by tendons and other tissues). They are the most prevalent type of muscle in the human body, comprising 30 to 40 percent of a person’s body weight.

**MISSION:** Label the illustrations on these two pages using the labels provided at the top of the facing page.

- **Stemocleidomastoid**
- **Serratus Anterior**
- **Rectus Abdominis**
- **Vastus Intermedius (under Rectus Femoris)**
- **Vastus Lateralis**
- **Vastus Medialis**
- **Deltoid**
- **Pectoralis Major**
- **Biceps Brachii**
- **External Oblique**
- **Sartorius**
- **Rectus Femoris**
- **Tibialis Anterior**
| Biceps Brachii | Pectoralis Major | Sternocleidomastoid |
| Biceps Femoris | Rectus Abdominis | Supraspinatus |
| Deltoid | Rectus Femoris | Teres Minor |
| External Oblique | Rhomboid Major | Tibialis Anterior |
| Gastrocnemius | Sartorius | Trapezius |
| Gluteus Medius | Semimembranosus | Triceps Brachii |
| Gluteus Maximus | Semitendinosus | Vastus Intermedius |
| Infraspinatus | Serratus Anterior | Vastus Lateralis |
| Latissimus Dorsi | Soleus | Vastus Medialis |
### 6.3 Agonist and Antagonist Muscle Pairs

In a muscle pair, the agonist muscle is primarily responsible for the movement of a body part (bone), whereas the antagonist muscle counteracts and lengthens when the agonist muscle contracts.

**MISSION:** Indicate the opposing muscle or muscle group in the table below.

<table>
<thead>
<tr>
<th>Agonist</th>
<th>Antagonist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triceps</td>
<td>Biceps brachii</td>
</tr>
<tr>
<td>Pectoralis major</td>
<td>Infraspinatus or latissimus dorsi</td>
</tr>
<tr>
<td>Hamstrings</td>
<td>Quadriceps (anterior)</td>
</tr>
<tr>
<td>Trapezius</td>
<td>Latissimus dorsi or pectoralis major</td>
</tr>
<tr>
<td>Gluteus maximus</td>
<td>Iliacus</td>
</tr>
<tr>
<td>Erector spinae group</td>
<td>Rectus abdominis</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>Tibialis anterior</td>
</tr>
<tr>
<td>Wrist flexors</td>
<td>Wrist extensors</td>
</tr>
<tr>
<td>Supinator</td>
<td>Pronator teres</td>
</tr>
<tr>
<td>Tibialis anterior</td>
<td>Gastrocnemius</td>
</tr>
<tr>
<td>Anterior deltoid</td>
<td>Posterior deltoid</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>Deltoid or pectoralis major/Minor</td>
</tr>
<tr>
<td>Iliacus</td>
<td>Gluteus maximus</td>
</tr>
<tr>
<td>Adductor magnus</td>
<td>Gluteus medius or gluteus minimus</td>
</tr>
<tr>
<td>External obliques</td>
<td>External obliques (opposite)</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>Pectoralis major</td>
</tr>
<tr>
<td>Rhomboids</td>
<td>Coracobrachialis</td>
</tr>
<tr>
<td>Sternocleidomastoid</td>
<td>Sternocleidomastoid (opposite)</td>
</tr>
</tbody>
</table>
6.4 The Anatomy of Skeletal Muscle

The basic unit of skeletal muscle is the individual skeletal muscle fibre or muscle cell. Looking outward and inward from this basic unit shows how skeletal muscle as a whole is constructed and how it functions.

**MISSION:** To gain familiarity with how skeletal muscle is constructed, label the key parts of the muscle and muscle fibre in the diagrams below. Some labels may need to be used more than once.

**Labels**
- Tendon
- Perimysium
- Epimysium
- Endomysium
- Sarcomere (partially contracted)
- Actin
- Muscle fibre
- Myofibril
- Myosin
- Sarcolemma (muscle membrane)
- Sarcoplasmic reticulum (web-like)
- Z-line

The structure of skeletal muscle.
6.5 The Neuromuscular System

The neuromuscular system is a general term referring to the complex linkage between the muscular system and the nervous system. It includes the brain, the spinal cord, the muscle fibres, and the neurons connecting them.

**MISSION:** To gain familiarity with the components of the neuromuscular system and neuromuscular junction, label the illustrations below.

**Labels**

- Axon
- Axon terminal
- Motor neuron
- Muscle fibres
- Neurotransmitter acetylcholine (ACh)
- Receptor
- Sarcolemma
- Synaptic cleft

---

A neuromuscular junction.

A motor unit.
## 6.6 Excitation-Contraction Coupling

Muscles work by converting chemical energy (ATP) into mechanical energy, but muscle contraction starts with an electrical impulse from the central nervous system. This process is known as "excitation-contraction coupling."

**MISSION:** A sequence of events occurs before, during, and after muscle contraction—for example, when you abduct your arm. The steps are described below. The initial, middle, and final steps are numbered correctly below. Re-number the other steps in the process in the correct order of their occurrence.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A message originates and is released from the central nervous system.</td>
</tr>
<tr>
<td>2</td>
<td>The message then travels from the axon branch to the axon terminal of the deltoide muscle.</td>
</tr>
<tr>
<td></td>
<td>Since the weight is minimal, only a few muscle fibres (a small motor unit) will be recruited.</td>
</tr>
<tr>
<td>3</td>
<td>The message is carried through the axon terminal via acetylcholine (ACh) to the sarcolemma of each muscle fibre involved.</td>
</tr>
<tr>
<td>4</td>
<td>ACh causes the sarcoplasmic reticulum to release calcium ions from the terminal cisterna.</td>
</tr>
<tr>
<td>5</td>
<td>The calcium ions then find their way to attachment sites on troponin, which are located on the actin's tropomyosin.</td>
</tr>
<tr>
<td>6</td>
<td>The tropomyosin swivels, causing the binding sites for myosin on the actin filament to be exposed.</td>
</tr>
<tr>
<td>7</td>
<td>The myosin heads attach themselves to the binding sites on actin.</td>
</tr>
<tr>
<td>8</td>
<td>ATP is broken down by ATPase, causing the power stroke and the sliding of actin along the myosin filament.</td>
</tr>
<tr>
<td>9</td>
<td>Contraction of the filaments will continue until you decide to stop the activation of the deltoide muscle. As long as calcium is present, contraction will continue.</td>
</tr>
</tbody>
</table>
6.7 The Reflex Arc

Reflex actions are how the body responds rapidly to painful—or the threat of painful—situations. The reflex arc is the pathway along which an initial stimulus and a corresponding response message travel.

MISSION: Label the illustration below using the labels on the left, and briefly describe the five components of the reflex arc in the space provided below.

1. Sensory receptor: receives the initial stimulus

2. Sensory neuron: carries the impulse to the spinal column or brain

3. Interneuron: interprets the signal and issues an appropriate response

4. Motor neuron: carries the response message from the spinal cord to the muscle or organ

5. Effector organ: carries out the response

Labels

- Effector Organ
- Interneuron
- Motor Neuron (afferent)
- Sensory Receptor
- Sensory Neuron (afferent)

The reflex arc.
6.8 Golgi Tendon Organs at Work

Golgi tendon organs are highly specialized proprioceptors (sensory receptors) found at the end of muscle fibres that merge into the tendon itself and that detect changes in muscle tension on the tendon.

**Mission**: The illustration below shows a tension reflex action involving the Golgi tendon organs. Referring to the components already labelled in the illustration below, list and describe the various stages of this reflex action.

1. The Golgi tendon organ detects increased tension exerted on the tendon.
2. A message (impulse) is transmitted along the afferent (sensory) neuron to the spinal cord.
3. The afferent neuron synapses with the efferent pathway (motor neuron) of the same muscle.
4. An impulse is then transmitted along the efferent pathway (motor neuron) to the muscle fibres.
5. The motor units respond to the impulse and the muscle relaxes, thereby preventing injury.

---

**Golgi tendon organ (tension detector).**

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Chapter 6 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 6. Complete each set of questions according to your teacher’s instructions.

Question Set 1: The Musculoskeletal and Neuromuscular Systems

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. The type of muscle associated with voluntary movement is referred to as
   (a) cardiac muscle
   (b) smooth muscle
   ✓ (c) skeletal muscle
   (d) none of the above

2. Skeletal muscle attaches to bone by means of
   (a) ligaments
   (b) cartilage
   ✓ (c) muscle fibre
   (d) tendons

3. Which of the following muscles dorsiflexes the ankle?
   (a) gastrocnemius
   (b) soleus
   (c) gluteus maximus
   ✓ (d) tibialis anterior

4. Which of the following muscles flex the knee?
   ✓ (a) semitendinosus, semimembranosus, and rectus femoris
   (b) vastus lateralis, vastus intermedius, vastus medialis, and rectus femoris
   (c) supraspinatus, infraspinatus, teres minor, and subscapularis
   (d) none of the above

5. Which muscles insert on the tibial tuberosity?
   (a) semitendinosus, semimembranosus, and biceps femoris
   ✓ (b) vastus lateralis, vastus medialis, vastus intermedius, and rectus femoris
   (c) supraspinatus and biceps femoris
   (d) gracilis, pectineus, and adductor brevis

6. Which muscles make up the rotator cuff?
   (a) trapezius, deltoid, and latissimus dorsi
   (b) biceps brachii, triceps brachii
   ✓ (c) supraspinatus, infraspinatus, teres minor, and subscapularis
   (d) iliopectoas, psoas major, and biceps brachii

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. What is meant by “agonist and antagonist muscle pairs”? Give an example.
   Since muscles pull on bones, another muscle (on the opposite side) is required to move the bone in the opposite direction. The muscle primarily responsible for movement of a body part is the agonist muscle. The muscle that counteracts the agonist, lengthening when the agonist muscle contracts, is the antagonist muscle. For example, your triceps muscle relaxes while the biceps contracts to lift a weight in your forearm.

2. List and describe the six properties of skeletal muscle that play a role in how muscles are named.
   Muscle action; direction of the fibre; location of the muscle; number of divisions/heads; shape of the muscle; muscle’s points of attachment.

3. What is meant by muscle “origin and insertion”?
   Body movements occur when muscles contract across joints and the point of insertion on the movable bone moves towards the point of origin on the immovable bone.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Describe how the neuromuscular junction functions as a critical part of the neuromuscular system. You may use a sketch in your answer.

2. Explain how motor units function according to a rule known as the "all or none principle" in relation to muscle contraction.

3. What are the most common muscle and tendon injuries and in what general ways are they treated?
Question Set 2: The Sliding Filament Theory, Proprioception, and the Body’s Reflexes

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. On a molecular level, during a muscle contraction, which structures attach, rotate, detach, and reattach in rapid succession in a ratchet-like fashion?
   (a) thick filaments
   (b) thin filaments
   (c) sarcomeres
   **✓** (d) myosin crossbridges

2. What is the "trigger mechanism" for the sliding filament process?
   **✓** (a) the release of calcium ions
   (b) the release of adenosine triphosphate (ATP)
   (c) the release of troponin
   (d) the release of tropomyosin

3. The process from the initial nerve impulse through to the final muscle contraction is known as
   (a) the knee-jerk response
   (b) the actin-myosin interaction
   **✓** (c) excitation-contraction coupling
   (d) none of the above

4. Three types of muscle contraction are
   (a) afferent, intermedia, and efferent
   (b) chemical, electrical, and mechanical
   (c) autonomic, automatic, and somatic
   **✓** (d) concentric, eccentric, and isometric

5. Sensory receptors within a muscle fibre that primarily detect changes in muscle length are
   (a) intrafusal muscle fibres
   **✓** (b) muscle spindles
   (c) sensory neurons
   (d) motor neurons

6. Golgi tendon organs (GTOs) are sensory receptors at the end of muscle fibres that detect changes in
   **✓** (a) muscle tension
   (b) muscle length
   (c) muscle movement
   (d) muscle strength

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. **What is meant by the "reflex arc"?**
   A simple neural pathway (or circuit) in the body along which the initial sensory stimulus and the corresponding response message travel.

2. **What are two important roles of the stretch reflex?**
   Present in all muscles, it plays an especially important role in the major extensor muscles of the limbs, e.g., the knee-jerk reflex. Also responsible for overcompensation responses when additional weight is suddenly placed on a weight-bearing muscle.

3. **As a kind of tension detection device for the muscle system, what protective role do GTOs play?**
   Help protect the muscle from excessive tension that would otherwise result in damage to the muscle or the joint or both.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Describe the sliding filament theory of muscle contraction.

2. Explain in general terms how the proprioceptor system plays an indispensable role in bodily movement.

3. Compare and contrast monosynaptic reflexes and polysynaptic reflexes.
7.1 Two Energy Systems, Three Metabolic Pathways

There are two energy systems (anaerobic and aerobic) but three “metabolic pathways.” This worksheet will help you distinguish these pathways and assist you in remembering how human energy systems work.

**Name:**

**Date:**

**MISSION:** The three metabolic energy pathways intersect and overlap continuously in all types of physical activity. Below, however, are photographs of athletes in three different sports that tend to rely more heavily on one of the three metabolic pathways over the others. In the space below each photograph, list other sports and physical activities that would rely heavily on one of the three pathways compared to the other two.

---

1: The ATP/PC System (Anaerobic Alactic)

- Shot put
- Olympic weightlifting
- 100-metre sprint
- Lunges
- Hammer throw event

2: Glycolysis (Anaerobic Lactic)

- Middle-distance race
- Hockey shifts
- Jumping hurdles (100 m)
- Medium-distance speed skating
- Medium-distance track events

3: Cellular Respiration (Aerobic)

- Marathon running
- Distance swimming
- Distance cycling
- Cross-country skiing
- Soccer

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**MISSION**: Examine the illustrations of the three metabolic energy pathways below. Explain what is happening in your own words.

1: ATP-PC
(Aerobic Alactic Pathway)

The ATP-PC system (also referred to as the phosphagen system), relies on the action of phosphocreatine, a compound that is normally stored in muscle and is readily accessible. Phosphocreatine (PC) is a high-energy molecule in which the phosphate can be broken off easily and which can be used to convert ADP back to ATP.

2: Glycolysis
(Aerobic Lactic Pathway)

During glycolysis, glucose is partially broken down to provide usable energy in the form of ATP. Glycolysis involves eleven separate biochemical reactions and yields twice as much ATP compared to the ATP-PC pathway. Like ATP-PC, this second metabolic pathway is also capable of producing ATP rapidly and without the need for oxygen. Through a series of chemical reactions, the process of glycolysis transfers energy from glucose and rejoins phosphate to ADP (adenosine diphosphate).

2: Cellular Respiration
(Aerobic Pathway)

The ATP produced by the aerobic method far exceeds the ATP produced by the other two pathways. Ultimately, 36 molecules of ATP are produced (or a couple more, depending on the fuel source) for every molecule of glucose—that is nearly 20 times the number of ATP molecules produced by the anaerobic system. It involves three separate sub-pathways: glycolysis (the "anaerobic lactic" pathway), the Krebs cycle, and the electron transport chain. This is the energy pathway that our bodies depend upon most heavily to sustain endurance-type events, such as a marathon run or swim or simply keeping going for an entire soccer match. The cellular respiration pathway results in the complete breakdown of glucose.
### 7.2 The Three Energy Pathways Compared

ATP-PC (the anaerobic alactic pathway), glycolysis (the anaerobic lactic pathway), and cellular respiration (the aerobic pathway) are the three basic energy pathways that supply the energy needed for working muscles.

**Name:** ____________  
**Date:** ____________

**MISSION:** Fill in the following table based on the criteria provided in the left-hand column.

<table>
<thead>
<tr>
<th></th>
<th>ATP-PC (Anaerobic alactic pathway)</th>
<th>Glycolysis (Anaerobic lactic pathway)</th>
<th>Cellular Respiration (Aerobic pathway)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location of activity</strong></td>
<td>Cytoplasm</td>
<td>Cytoplasm</td>
<td>Mitochondria</td>
</tr>
<tr>
<td><strong>Energy source</strong></td>
<td>Creatine phosphate</td>
<td>Glucose (glycogen)</td>
<td>Glycogen, fats, proteins</td>
</tr>
<tr>
<td><strong>Uses oxygen or not</strong></td>
<td>Anaerobic (without oxygen)</td>
<td>Anaerobic (without oxygen)</td>
<td>Aerobic (with oxygen)</td>
</tr>
<tr>
<td><strong>ATP produced</strong></td>
<td>1 molecule</td>
<td>2 molecules per molecule of glucose</td>
<td>36 molecules per molecule of glucose</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>10-15 seconds</td>
<td>15 seconds to 3 minutes</td>
<td>120 seconds and beyond</td>
</tr>
<tr>
<td><strong>Number of chemical reactions</strong></td>
<td>1-2</td>
<td>11</td>
<td>Glycolysis, Krebs cycle, and the electron transport chain</td>
</tr>
<tr>
<td><strong>By-products</strong></td>
<td>None</td>
<td>Lactic acid</td>
<td>Water and carbon dioxide</td>
</tr>
<tr>
<td><strong>Basic chemical reaction formula</strong></td>
<td>PC + ADP $\rightarrow$ ATP + Creatine</td>
<td>$C_6H_{12}O_6 + 2ADP + 2P$ $\rightarrow$ $2C_2H_4O_2 + 2ATP + 2H_2O$</td>
<td>$C_6H_{12}O_6 + 6O_2 + 36ADP + 36P$ $\rightarrow$ $6CO_2 + 36ATP + 6H_2O$</td>
</tr>
<tr>
<td><strong>Type of activities</strong></td>
<td>Power surges, speed events</td>
<td>Intermediate activities/sprint finish</td>
<td>Prolonged activities</td>
</tr>
<tr>
<td><strong>Types of exercise that rely on this system</strong></td>
<td>Sprints, jumping, weightlifting</td>
<td>200-800-metre runs; a shift in hockey</td>
<td>Marathons</td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>Very quick surge of power</td>
<td>Quick surge of power</td>
<td>Long duration; complete breakdown of glucose</td>
</tr>
<tr>
<td><strong>Limitation of energy system</strong></td>
<td>Short duration; muscles store small amounts of ATP and creatine phosphate</td>
<td>Buildup of lactic acid causes pain and fatigue</td>
<td>Slow; requires large amount of oxygen</td>
</tr>
</tbody>
</table>

128 * Chapter 7. Energy Systems and Physical Activity  
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7.3 Energy Pathways and Athletic Performance

Every sport or activity involves the use of the three energy pathways to varying degrees, depending on the sport's unique requirements. Some sports rely more heavily on one pathway while others use a combination of all three.

**MISSION:** Complete the following chart by indicating the extent (expressed as a percentage or as "highly," "moderately," or "seldom used") to which the activities listed below rely on each of the three energy pathways. In the remaining spaces in the left-hand column, choose as many additional sports as you can and provide the same information in the corresponding columns.

### Energy Systems For Various Sports

<table>
<thead>
<tr>
<th>Sport or Activity</th>
<th>ATP-PC (Anaerobic Alactic Pathway)</th>
<th>Glycolysis (Anaerobic Lactic Pathway)</th>
<th>Cellular Respiration (Aerobic Pathway)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olympic weightlifting</td>
<td>Highly</td>
<td>Seldom used</td>
<td>Seldom used</td>
</tr>
<tr>
<td>Endurance running</td>
<td>Seldom used</td>
<td>Moderately</td>
<td>Highly</td>
</tr>
<tr>
<td>100-metre sprint</td>
<td>Highly</td>
<td>Moderately</td>
<td>Seldom used</td>
</tr>
<tr>
<td>A 30-second shift in hockey</td>
<td>Moderately</td>
<td>Highly</td>
<td>Seldom used</td>
</tr>
</tbody>
</table>
WORKSHEET

Chapter 7 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 7. Complete each set of questions according to your teacher’s instructions.

Name: 
Date:

Question Set 1: Energy Sources and Energy Systems in the Human Body

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. To be usable as sources of energy, the nutrients (proteins, fats, and especially carbohydrates) in our food must be resynthesized in our bodies into
   - (a) adenosine triphosphate (ATP)
   - (b) glycogen
   - (c) phosphocreatine
   - (d) phosphate
   ✓ (a) adenosine triphosphate (ATP)

2. Which of the following sport activities primarily use the ATP-PC system?
   - (a) circuit training
   - (b) shot put
   - (c) 400-metre sprint
   - (d) all of the above
   ✓ (b) shot put

3. Which of the following is the main product of glycolysis?
   - (a) acetyl CoA
   - (b) pyruvate
   - (c) ATP
   - (d) creatine phosphate
   ✓ (b) pyruvate

4. Cellular respiration involves which of the following energy sub-pathways?
   - (a) glycolysis
   - (b) Krebs cycle
   - (c) electron transport chain
   - (d) all of the above
   ✓ (d) all of the above

5. Upon which energy system does a marathon runner rely heavily?
   - (a) ATP-PC
   - (b) glycolysis
   - (c) cellular respiration
   - (d) none of the above
   ✓ (c) cellular respiration

6. During physical exercise, our bodies’ primary sources of energy are
   - (a) proteins and fats
   - (b) proteins and carbohydrates
   - (c) carbohydrates and fats
   - (d) none of the above
   ✓ (c) carbohydrates and fats

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. What are the three metabolic pathways by which energy from ATP is produced for use in our bodies? ATP-PC (anaerobic lactic), glycolysis (anaerobic lactic), and aerobic (cellular respiration).

2. Under certain conditions, glycolysis could be considered the first stage of cellular respiration. What are these conditions? Under aerobic conditions (when oxygen is readily available to the muscles), pyruvate is the beginning of the third (aerobic) system that eventually leads to the complete breakdown of glucose and to very large quantities of ATP.

3. What is “lactic acid buildup” and why is it sometimes a problem for athletes? In the absence of adequate oxygen supplies (e.g., during intense exercise or exercise at high altitudes), pyruvic acid is converted to lactic acid and exhaustion and muscle pain set in.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions:

1. Identify the body’s two main energy systems, describe the three metabolic pathways within those systems, and state the factors that place limits on each of these pathways.

2. During which types of sports and performance events does the anaerobic lactic system contribute little energy? Why is this so?

3. Each energy pathway results in different quantities of ATP. How much ATP is associated with each pathway? Explain.
Question Set 2: Muscle Fibre Types and Human Performance

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Slow-twitch muscle fibres contain high amounts of this oxygen storage unit.
   (a) haemoglobin
   (b) myosin ATPase
   (c) alanine
   (d) myoglobin
   - (d) myoglobin

2. Fast-twitch muscle fibres
   (a) are red/dark in colour; tense and relax slowly
   (b) are pale in colour; tense and relax quickly
   (c) can activate at a rate two to three times faster than slow-twitch muscle fibres
   - (d) (b) and (c) are correct

3. Which of the following muscles are likely to contain a large amount of fast-twitch fibres?
   (a) quadriceps
   (b) erector spinae
   (c) hamstrings
   - (d) eyelids

4. Which type of muscle fibre do exercise physiologists believe can be modified as a consequence of aerobic endurance training?
   (a) Type I or Slow Oxidative (SO)
   (b) Type IIA or Fast-Oxidative Glycolytic (FOG)
   (c) Type IIB or Fast-Glycolytic (FG)
   - (d) none of the above

5. Which of the following non-physiological factors could be associated with the remarkable achievement of East African distance runners?
   (a) unique local customs and culture
   (b) the example set by other East African athletes
   (c) potential financial gain for their families
   - (d) all of the above

6. Which female African distance runner won gold in the 10,000-m race at the 2012 London Olympics?
   - (a) Ethiopia's Tirunesh Dibaba
   - (b) Kenya's Vivian Cheruiyot
   - (c) Ethiopia's Meseret Defar
   - (d) Kenya's Linet Masai

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. Describe the characteristics of fast-twitch and slow-twitch muscle fibres.
   Fast-twitch muscle fibres are more pale in colour, have the ability to tense and relax quickly, and can generate large amounts of tension with relatively low endurance levels. Slow-twitch muscle fibres are red or dark in colour, and generate and relax tension relatively slowly. The trade-off, however, is that they are able to maintain a lower level of tension for long durations.

2. Explain the role of the protein myoglobin with respect to muscle fibre types.
   The protein myoglobin is the oxygen storage unit that delivers oxygen to working muscles, thereby enabling energy-producing biochemical reactions to be sustained over a long time period. The differences in muscle fibre types are due mainly to the extent to which a particular muscle relies on oxygen in the production of energy.

3. Exercise physiologists distinguish an "intermediate" muscle fibre type. What is unique about this particular muscle fibre type?
   There is research suggesting that Type IIB fibres can, as a consequence of aerobic endurance training, become Type IIA fibres (whereas Type IIA fibres do not make the transition to Type I fibres).

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions:

1. Draw up a table that lists and compares the characteristics of slow-twitch and fast-twitch muscle fibre.

2. East African distance runners win a disproportionate number of endurance races. Describe some factors that might account for their successes.

3. Explain why training at high altitude may help endurance athletes when they compete at sea level.
8.1 The Anterior Structure of the Heart

The anterior view of the heart reveals the major structures of the heart: the coronary vessels (the coronary arteries and the coronary veins), and the four separate chambers that make up the heart.

MISSION: Label the illustration below using the list of labels provided.

Labels

- Anterior interventricular branch of left coronary artery
- Aorta
- Branches of left pulmonary artery
- Branches of right pulmonary artery
- Great cardiac vein
- Inferior vena cava
- Left atrium
- Left pulmonary artery
- Left pulmonary veins
- Left ventricle
- Pulmonary trunk
- Right atrium
- Right coronary artery
- Right pulmonary veins
- Right ventricle
- Small cardiac vein
- Superior vena cava
- Thoracic aorta (descending)

Anterior view of the coronary vessels, including other major heart structures.
8.2 The Flow of Blood within the Heart

The heart is a complex organ formed from specialized muscle tissue called myocardium. The heart acts as the “pump” of the cardiovascular system, pushing blood through the blood vessels throughout the body.

MISSION: To gain familiarity with the heart’s key internal components, label the illustration below. Some labels may need to be used more than once. Next, colour parts of the heart and the arrows to indicate the circulation of oxygenated blood (red) and deoxygenated blood (blue) throughout the heart.

Labels

- Aortic semilunar valve
- Bicuspid (mitral) valve
- Chordae tendinae
- Interventricular septum
- Left atrium
- Left ventricle
- Papillary muscles
- Pulmonary semilunar valve
- Right atrium
- Right pulmonary veins
- Right ventricle
- Tricuspid valve

Internal anatomy of the heart and the blood pathway through the heart.
8.3 The Electrical Conduction System of the Heart

The electrical conduction system of the heart is an intricate and continuous system that allows the heart to function properly. Cardiac muscle cells are interconnected and allow the passage of electrical signals from cell to cell.

MISSION: To gain a better understanding of the processes involved in the heart’s electrical conduction system and to identify the components involved in this system, label the illustration below and colour the nerves (using a yellow marker or pencil crayon).

Labels

- Atrioventricular (AV) node
- Bundle of His (AV bundle)
- Internodal pathways
- Purkinje fibres
- Right and left bundle branches
- Sinoatrial (SA) node

The electrical conduction system of the heart.
8.4 The Structure of the Cardiovascular System

The cardiovascular system is comprised of large and small blood vessels. Oxygenated blood goes out to the body from the heart and deoxygenated blood flows back to the heart, and then to the lungs.

**MISSION:** To gain a better understanding of the components and function of the essential structure of the cardiovascular system, label the illustration below. Note the arrows indicating the direction of the flow of blood as you are labelling the illustration.

**Labels**

- Arteriole
- Capillaries
- Capillary bed
- Large arteries
- Large veins
- Medium arteries
- Medium veins
- Venules

The cardiovascular system.
8.5 The Structure of the Respiratory System

The respiratory system is composed of many interconnected parts that allow the passage of air. The structure of the respiratory system can be divided into two main zones: the conductive zone and the respiratory zone.

**MISSION:** Label the illustration below using the list of labels provided, and indicate the two main structures.

**Labels**

- Alveolar sacs
- Alveoli
- Conductive zone
- Epiglottis
- Larynx
- Left and right primary bronchi
- Left lung (2 lobes)
- Mouth
- Nasal cavity
- Pulmonary arteriole (carrying deoxygenated blood)
- Pulmonary venule (carrying oxygenated blood)
- Right lung (3 lobes)
- Smooth muscle
- Terminal bronchiole
- Trachea
- Respiratory zone

The main structures of the respiratory system.
8.6 External and Internal Respiration

External respiration involves the exchange of O₂ and CO₂ in the lungs. Internal respiration refers to the exchange of gases at the tissue level where CO₂ is delivered and CO₂ is removed from the blood.

**MISSION:** To gain a better understanding of the structure and function of the external and internal respiration pathways, label the illustration below. Some labels may need to be used more than once. Next, colour the oxygenated blood (red) and the deoxygenated blood (blue) to demonstrate blood flow.

**Labels**
- Brain
- Cellular respiration
- External respiration
- Heart
- Internal respiration
- Lungs
- Mitochondria
- Pulmonary arteries
- Pulmonary capillaries
- Pulmonary veins
- Systemic arteries
- Systemic capillaries
- Systemic veins
- Tissue cell

External and internal respiration in the human body.
Chapter 8 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 8. Complete each set of questions according to your teacher's instructions.

Name: ________________________
Date: _________________________

Question Set 1: The Cardiovascular System—Structure and Function

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. Which of the following blood vessels drains the head, the neck, and the arms?
   (a) the pulmonary artery
   (b) the inferior vena cava
   ✓ (c) the superior vena cava
   (d) the aorta

2. The bicuspid (mitral) valve is located between
   (a) the right ventricle and the pulmonary artery
   (b) the left ventricle and the aorta
   ✓ (c) the left atrium and the left ventricle
   (d) the right atrium and the right ventricle

3. Which of the following blood vessels carries deoxygenated blood from the heart to the lungs?
   (a) the pulmonary vein
   (b) the coronary arteries
   (c) the aorta
   ✓ (d) the pulmonary artery

4. This structure in the heart is sometimes referred to as the heart's "pacemaker."
   (a) the pulmonary semilunar valve
   (b) the myocardium
   (c) the atrioventricular (AV) node
   ✓ (d) the sinoatrial (SA) node

5. Cardiac output is equal to which of the following?
   (a) heart rate x breathing rate
   ✓ (b) heart rate x stroke volume
   (c) heart rate x aortic blood pressure
   (d) resting heart rate

6. Which of the following remains unaffected with respect to blood distribution during exercise?
   ✓ (a) the brain
   (b) the digestive system
   (c) the skeletal muscle
   (d) the muscular system

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. What are the three main tools, or systems, that the body uses to assist in the return of blood in the veins back to the heart?
   The skeletal muscle pump, the thoracic pump, and the nervous system, i.e., venoconstriction.

2. What are the main components of human blood?
   Plasma (consisting of water, plasma proteins, acids, and salts), red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes).

3. What is meant by systolic and diastolic blood pressure?
   Systolic blood pressure is the maximum pressure observed in the arteries during the contraction phase of the ventricle (e.g., 120 mmHg); diastolic blood pressure is the minimum pressure observed in the arteries during the relaxation phase of the ventricle (e.g., 80 mmHg).

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Trace the path of blood through the heart, briefly explaining the role of each component of the cardiovascular system.

2. Discuss several risk factors that may lead to coronary heart disease, and suggest ways to offset such disease.

3. What are some distinguishing characteristics of an elite athlete's heart?
Question Set 2: The Cardiorespiratory System—Structure and Function

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. The respiratory zone is composed of the  
   (a) pharynx, trachea, and respiratory bronchioles  
   (b) mouth, nose, bronchi, and alveolar sacs  
   (c) trachea, bronchi, bronchioles, and alveolar ducts  
   ✅ (d) respiratory bronchioles, alveolar ducts, and alveolar sacs

2. As the diaphragm contracts, the thoracic cavity  
   (a) tightens and shrinks  
   ✅ (b) pulls downwards and enlarges  
   (c) remains fairly stationary and in place  
   (d) recoils to its original position

3. The smallest vessels in the cardiovascular system that are responsible for the exchange of gases are  
   (a) arteries  
   (b) veins  
   (c) arterioles  
   ✅ (d) capillaries

4. The maximal amount of O₂ that can be taken in and used for the metabolic production of ATP during exercise is known as  
   (a) O₂ uptake  
   (b) VCO₂  
   ✅ (c) VO₂max  
   (d) RER

5. The difference between the oxygen required to perform a task and the oxygen actually consumed prior to reaching a new steady state is known as the  
   (a) CO₂ deficit  
   (b) a-vO₂ diff  
   ✅ (c) O₂ deficit  
   (d) OBLA

6. The point where blood lactate concentrations begin to increase is referred to as  
   (a) the ventilatory threshold  
   (b) excess post-exercise oxygen consumption  
   (c) blood lactate accumulation  
   ✅ (d) the lactate threshold

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. With reference to the cardiorespiratory system, what is meant by the “conductive zone”?
   All the structures that convey air from the outside of the body through to the lungs—the mouth and nose; pharynx; larynx; trachea; primary and secondary bronchi; and tertiary bronchioles and terminal bronchioles.

2. What is meant by “external respiration” and “internal respiration”?
   External respiration: the processes that occur within the lungs involving the exchange of O₂ and CO₂. Internal respiration: the exchange of gases at the tissue level, where O₂ is delivered and CO₂ is removed.

3. What does “a-vO₂ diff” refer to?
   The difference between the amount of O₂ in the artery and the vein, reflecting the amount of O₂ delivered to the muscle.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Describe the mechanisms of breathing.

2. Describe the factors that affect gas exchange (the rates of diffusion of O₂ and CO₂ at the lungs and the tissues).

3. Explain what is meant by VO₂max and what factors affect it.

4. Identify and describe the kinds of diseases that can affect the respiratory system.
9.1 Factors Affecting Human Growth and Development

Human growth and development are complex processes involving several interrelated components. These components vary from one person to the next, and they all contribute to an individual’s overall development.

The Four Components of Human Growth and Development: An Overview

MISSION: Review the graphic representation below, which shows the four components of human growth and development. On the next page, list the various factors that affect each of these components.

**Components of Human Growth and Development**

Each of the four components of human growth and development takes on unique characteristics at each stage of an individual’s life, and each component is integrated with the other three components.

**Physical**
Our rate of bodily growth—changes in physical structure and appearance—is not constant but tends to occur in “spurts” of rapid change.

**Cognitive**
The brain’s capacity to process information and to perform increasingly complex intellectual tasks increases as our bodies develop.

**Social**
Healthy interpersonal relationships are fostered by having opportunities for co-operation, teamwork, and group problem solving.

**Emotional**
As we mature, we tend to develop greater self-awareness, an enhanced ability to manage our emotions, and greater empathy for others.
Identifying Specific Factors Affecting Human Growth and Development

Work with a small group of classmates on this exercise. Referring to the graphic representation on the previous page, compile a list of the various factors that affect each component of human growth and development. For each component, list four key factors that exert an influence on that component.

<table>
<thead>
<tr>
<th>Physical Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity/Active for life (60 minutes per day at least)</td>
</tr>
<tr>
<td>Healthy nutrition</td>
</tr>
<tr>
<td>Genetics/heredity (and interaction of genetics with the environment)</td>
</tr>
<tr>
<td>Hormones/glandular activity</td>
</tr>
<tr>
<td>Diseases and injuries</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cognitive Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity (60 minutes per day at least)</td>
</tr>
<tr>
<td>Stimulating experiences that are rich and varied</td>
</tr>
<tr>
<td>Education</td>
</tr>
<tr>
<td>Healthy nutrition</td>
</tr>
<tr>
<td>Ability to adapt to one's environment—intelligence</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Play and participation in sports</td>
</tr>
<tr>
<td>Positive and nurturing early relationships with caregiver, family</td>
</tr>
<tr>
<td>Friendships</td>
</tr>
<tr>
<td>Social values and norms</td>
</tr>
<tr>
<td>Cultural expectations and customs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emotional Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membership in a sports team, athletics club, or other organized group that provides a sense of security and belonging</td>
</tr>
<tr>
<td>Positive and nurturing early experiences and relationships</td>
</tr>
<tr>
<td>Interactions with friends</td>
</tr>
<tr>
<td>Development of positive coping mechanisms/resilience</td>
</tr>
<tr>
<td>Strong bonds within family and community (love and support)</td>
</tr>
</tbody>
</table>
### 9.2 Create Your Own Personal Development Timeline

Experts in the area of human growth and development sometimes speak of "developmental milestones"—significant events such as learning to walk and talk or making friendships for the first time.

**Name:**

**Date:**

**MISSION:** Fill in as much of the chart as possible to create your own personal development timeline. Record the most significant events, or milestones, in your physical, cognitive, social, and emotional development.

<table>
<thead>
<tr>
<th>Ages</th>
<th>Physical Development</th>
<th>Cognitive Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ages 1-5</td>
<td>Learned to crawl on all fours by nine months and walk with assistance by the age of one.</td>
<td>Learned to recognize and recite the letters of the alphabet by age 3</td>
</tr>
<tr>
<td>Ages 6-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ages 11-15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 16+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Development</td>
<td>Emotional Development</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td>Participated in a neighbourhood play group at the age of 4.</td>
<td>Felt proud to be able to ride a bike without training wheels by the age of 5.</td>
<td></td>
</tr>
</tbody>
</table>
Worksheet

Chapter 9 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 9. Complete each set of questions according to your teacher's instructions.

Name: ___________________________

Date: ___________________________

Question Set 1: Physical Growth and Development

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. Human physical development encompasses
   (a) an individual's ability to interpret information
   (b) the ability to perform a wide range of tasks
   (c) relationships with peers, friends, and others
   ✓ (d) none of the above

2. Skeletal age
   (a) is indicated by the degree of ossification of bones
   (b) can be predicted according to chronological age
   (c) can be affected by diet, disease, and injury
   ✓ (d) all of the above

3. Which stage of human growth witnesses the most rapid physical development?
   ✓ (a) infancy/toddler
   (b) childhood
   (c) puberty/adolescence
   (d) adulthood

4. Significantly noticeable changes in physical appearance and body function in both sexes occur during
   (a) infancy
   (b) childhood/toddler
   ✓ (c) puberty/adolescence
   (d) adulthood

5. Which system secretes hormones to the body's various organs and tissues?
   (a) reproductive system
   (b) nervous system
   ✓ (c) endocrine system
   (d) lymphatic system

6. For youth aged 12-17, the Canadian Physical Activity Guidelines recommend at least
   ✓ (a) 60 minutes of physical activity per day
   (b) 30 minutes of physical activity per day
   (c) 120 minutes of physical activity per day
   (d) 90 minutes of physical activity per day

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. What are the differences between chronological, skeletal, and developmental age?
   Chronological age—measured in years, months, and days;
   Skeletal age—refers to the physical maturity of the skeleton;
   Developmental age—expressed as one's ability to perform certain tasks (motor skills).

2. List the four key stages of human development.
   Infancy/toddler, childhood, puberty/adolescence, adulthood

3. List five factors affecting physical growth and development.
   Glandular and hormonal activity; heredity; nutrition and diet; physical activity; and socio-cultural factors

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Expand on the statement “Not all body parts and systems undergo physical change at the same rate.”

2. Explain some implications of differing rates of physical development among adolescents.

3. From the perspective of the Canadian Society for Exercise Physiology (CSEP), what can we do throughout our lives to optimize our growth and development?
Question Set 2: Cognitive, Social, and Emotional Development and Activity Adaptation

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. The most widely accepted model of the stages of cognitive development was developed by
   - (a) Jean Piaget
   - (b) John Ratey
   - (c) Jacob Sattelmeir
   - (d) Henriette van Praag
   ✓ (d) all of the above

2. The benefits of aerobic exercise include
   - (a) neurogenesis (the birth of new neurons)
   - (b) enhanced brain plasticity
   - (c) prevention of brain tissue loss in older adults
   ✓ (d) all of the above

3. Children learn the give and take of social behaviour in general by interacting frequently with
   - (a) teachers
   - (b) friends
   - (c) role models
   - (d) parents or guardians
   ✓ (b) friends

4. The Long-Term Athlete Development (LTAD) model takes into account a child’s
   - (a) chronological age
   - (b) willingness to participate in physical activity
   - (c) development and maturation
   - (d) friendship network
   ✓ (c) LTAD growth tracking tables

5. A teacher or coach can identify a child as an early, average, or late maturer by using
   - (a) peak height velocity charts
   - (b) measurements of height, weight, and fat percentage
   - (c) LTAD growth tracking tables
   - (d) CSEP's Canadian Physical Activity Guidelines
   ✓ (a) peak height velocity charts

6. It is important to design movement-based activities for children that match their physical, cognitive, social, and emotional abilities; such activities are described as
   - (a) developmentally appropriate
   - (b) socially beneficial
   - (c) child-centred
   - (c) character-building
   ✓ (a) developmentally appropriate

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. What are the four stages of Jean Piaget’s model of cognitive development?
   Sensorimotor, pre-operational, concrete operational, and formal operational.

2. List ways in which participation in sport and physical activity can enhance children’s social development.
   Provides opportunities to establish and maintain bonds of friendship; team sports teach cooperation and foster a sense of shared responsibility among young athletes; children learn to interact with adults, e.g., coaches, who are not parents.

3. Why does Canadian Sport for Life promote the Long-Term Athlete Development (LTAD) model?
   Helps children become physically literate; helps ensure a positive experience for kids in sport and physical activity; provides a pathway to excellence from playground to podium; allows all Canadians to be physically active throughout their lives; supports children in pursuing their dreams to compete in sport at the national/international level.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions:

1. Why is the modern field of child development indebted to Piaget’s insights?

2. Discuss the role that sport participation and team membership can play in social interaction and relationship building.

3. Describe various ways to modify games, sports, or activities to match the developmental characteristics of children of varying ages, stages, and ability levels.
**10.1 Motor Skills Observation Lab**

When coaches and athletes break down the phases of a motor skill into key elements, they can look for ways to improve the execution of the skill. It is best to complete this exercise after you have studied Chapters 11-13 and 15.

(a) Hockey Skills Observation

**MISSION:** Using the photographs above, identify the key elements of each phase of the skill and indicate training exercises that might result in improvement at each phase.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Key Elements of Phase</th>
<th>Training Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preliminary movements</td>
<td>Athletic stance&lt;br&gt;Shoulders squared&lt;br&gt;Stick ready</td>
<td>Balance and core exercises (plank, squats)</td>
</tr>
<tr>
<td>2. Back swing movements</td>
<td>Widen stance&lt;br&gt;Twisted torso&lt;br&gt;Stick up</td>
<td>Shoulder, back, and obliques (twisting sit-ups)</td>
</tr>
<tr>
<td>3. Force-producing movements</td>
<td>Stance widened&lt;br&gt;Back foot pivoted; drive off back leg&lt;br&gt;Stick contact with puck. Shoulders squared</td>
<td>Leg exercises (power, plyometrics)</td>
</tr>
<tr>
<td>4. Critical instant</td>
<td>Swing comes in front of body&lt;br&gt;Big joints—little joints&lt;br&gt;Stick exerts force on puck</td>
<td>Forearm exercises (obliques)&lt;br&gt;Hand-eye coordination (reaction ball)</td>
</tr>
<tr>
<td>5. Follow-through</td>
<td>Stick in air&lt;br&gt;Torso fully twisted&lt;br&gt;Looking forward</td>
<td>Twisting, transfer of weight&lt;br&gt;Can practise swing against resistance</td>
</tr>
</tbody>
</table>
**MISSION:** Using the photographs above, identify the key elements of each phase of the skill and indicate training exercises that might result in improvement at each phase.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Key Elements of Phase</th>
<th>Training Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preliminary movements</td>
<td>Athletic stance&lt;br&gt;Shoulders squared&lt;br&gt;Eyes focused on ball</td>
<td>Balance and core exercises (plank, squats)&lt;br&gt;Speed, agility, and quickness training</td>
</tr>
<tr>
<td>2. Back swing movements</td>
<td>Small steps, if necessary, as you approach the ball&lt;br&gt;Non-kicking foot planted firmly&lt;br&gt;Full backward swing of leg, slight flex at kicking knee</td>
<td>Squats, leaps, plyometric drills&lt;br&gt;Flexibility exercises&lt;br&gt;Speed, agility, and quickness training</td>
</tr>
<tr>
<td>3. Force-producing movements</td>
<td>Sequeced joint rotation at the hip, knee and ankle&lt;br&gt;Weight shifting forward</td>
<td>Leg exercises (power, plyometrics)&lt;br&gt;Speed, agility, and quickness training</td>
</tr>
<tr>
<td>4. Critical instant</td>
<td>Move arms to keep centre of mass positioned over supporting leg&lt;br&gt;Contact ball flush centre to produce straightline trajectory&lt;br&gt;Contact ball off-centre to produce ball spin during flight</td>
<td>Leg exercises (power, plyometrics)&lt;br&gt;Speed, agility, and quickness training</td>
</tr>
<tr>
<td>5. Follow-through</td>
<td>Continuous upswing movement of kicking leg after striking the ball&lt;br&gt;Maintain balance</td>
<td>Twisting, transfer of weight&lt;br&gt;Can practise swing against resistance&lt;br&gt;Speed, agility, and quickness training</td>
</tr>
</tbody>
</table>
**MISSION:** Using the photographs above, identify the key elements of each phase of the skill and indicate training exercises that might result in improvement at each phase.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Key Elements of Phase</th>
<th>Training Exercises</th>
</tr>
</thead>
</table>
| 1. Preliminary movements     | Athletic stance over the ball.  
Ensure balanced position  
Legs slightly bent.  
Grip club gently                      | Balance and stability exercises                                                       |
| 2. Back swing movements      | Ensure coordinated rotation back at shoulder, hips and core.  
Ensure full extension of arms         | Core strength and flexibility exercises                                               |
| 3. Force-producing movements | Shift weight forward and swing core, hips and arms forward                             | Core strength exercises, back extensions                                             |
| 4. Critical instant          | Ensure coordinated joint rotations so that maximum torque forces are brought to bear on impact with the golf ball.  
Eyes focused on ball                  | Core strength exercises, back extensions                                             |
| 5. Follow-through            | Uninterrupted upswing back over shoulder                                               | Core strength exercises, back extensions                                             |
**Mission:** Using the photographs above, identify the key elements of each phase of the skill and indicate training exercises that might result in improvement at each phase.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Key Elements of Phase</th>
<th>Training Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preliminary movements</td>
<td>Maintain athletic position, Maintain balance, Legs and back slightly bent, Racquet forward in two hands</td>
<td>Stability and balance exercises</td>
</tr>
<tr>
<td>2. Back swing movements</td>
<td>Toss ball straight up in front while bending legs and swinging racquet behind body, Maintain fluid and coordinated motion</td>
<td>Leg and back strengthening exercise (squats, back extensions)</td>
</tr>
<tr>
<td>3. Force-producing movements</td>
<td>Thrust forward with racquet arm, gaining power from joint rotations at the shoulder, elbow, and eventually wrist. Use leg extension at the knee to gain extra power in stroke. Coordinate swing so as to hit the ball high above head.</td>
<td>Core exercises that strengthen and allow twisting of the trunk</td>
</tr>
<tr>
<td>4. Critical instant</td>
<td>Coordinate rotational movements to get maximum torque on impact with the ball, Strike the ball flush to get straight line movement on the ball or off-centre to get spin.</td>
<td>Coordination exercises to perfect joint sequencing and timing of impact</td>
</tr>
<tr>
<td>5. Follow-through</td>
<td>Fall slightly forward naturally from serving action, bringing racquet to other side of body. Maintain balance and stability so as to be ready for return.</td>
<td>Core exercises that allow full range of motion on follow-through and ensure stability and balance on completion</td>
</tr>
</tbody>
</table>
Chapter 10 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 10. Complete each set of questions according to your teacher’s instructions.

**Question Set 1: Motor Learning and Skill Acquisition**

**Multiple-Choice Questions**

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. The process through which a person develops the ability to perform and refine a task or skill is called
   (a) physical development
   (b) psychological development
   (c) rudimentary learning
   (d) motor learning
   ✔ (d) motor learning

2. The root of any motor activity lies in the
   (a) musculoskeletal system
   (b) sensory and nervous systems
   ✔ (c) decision mechanism
   (d) effector mechanism

3. What is the name given to the body’s “mechanism” that coordinates the mental commands and physical responses needed to produce movement?
   ✔ (a) effector
   (b) decision
   (c) memory
   (d) perceptual

4. The earliest and still most widely used approach to understanding how humans acquire skills is the
   (a) Long-Term Athlete Development Model
   ✔ (b) stages of motor learning model
   (c) Newell’s Model of Constraints
   (d) Gallahue and Donnelly’s five-step approach to KP feedback

5. The three basic categories of fundamental movement skills are
   (a) stability, flexibility, and manipulation
   ✔ (b) stability, locomotion, and manipulation
   (c) stability, rotation, and manipulation
   (d) stability, coordination, and manipulation

6. The ability to apply skills learned in the context of improving performance in one activity to a different activity is called
   (a) skill versatility
   (b) skill specialization
   (c) skill transferability
   ✔ (d) skill consolidation

**Short-Answer Questions**

**MISSION:** Briefly answer the following questions in the space provided:

1. For a learner to improve skill performance, what type of feedback is most effective?
   Feedback, whether KP or KR, that is positive, constructive, and specific.

2. Into which three components or phases of movement can a skill be broken down?
   Preparation phase, execution phase, and follow-through phase.

3. Why is skill transferability important when learning new motor skills?
   The ability to apply skills to a new situation is invaluable insofar as it helps to avoid having to re-learn many skills, and skill transferability contributes to an individual’s physical literacy.

**Essay Questions**

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Apply the stages of learning model developed by Fitts and Posner in describing how someone develops proficiency in learning to throw a ball.

2. Explain the important role of feedback in skill acquisition and performance. Distinguish between two categories of feedback.

3. Explain how participation in well-structured physical activities that develop fundamental movement skills helps children develop physical literacy over the long term.
Question Set 2: Sport Psychology and the Important Role of Coaching in Skill Acquisition

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. The role of sports psychologist includes
   (a) teaching athletes how to block out crowd noise
   (b) working with coaches and athletes to improve motivation
   (c) helping competitors to avoid feelings of anxiety that inhibit performance
   (d) all of the above

2. In the mind of an athlete, a sense of effortlessness and the feeling that time has "stayed still" describes
   (a) "the zone"
   (b) an ideal performance state
   (c) choking
   (d) both (a) and (b) are correct

3. Breathing control exercises, progressive relaxation exercises, meditation, and imagery all help control
   (a) arousal
   (b) relaxation
   (c) anxiety
   (d) concentration

4. Techniques for improved concentration include
   (a) positive self-talk
   (b) neurofeedback training
   (c) use of cue words
   (d) all of the above

5. Skills that emphasize attitude, positive focus, imagination, effort, and fun are known as
   (a) visualization strategies
   (b) coping strategies
   (c) motivational skills
   (d) mental fitness skills

6. Successful coaches continuously seek to
   (a) help athletes develop relaxation, imagery, concentration and coping skills
   (b) remain alert to symptoms of burnout, anxiety, or depression in their athletes
   (c) improve relationships with their athletes
   (d) all of the above

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. Define motivation in sport and list several key factors that are associated with motivation.
   Focus and intensity of effort; extrinsic motivational factors include material rewards; intrinsic motivational factors include the quest for excellence and personal goal improvement. Other key factors include personal traits vs. the environment; multiple motives; the challenge of staying motivated; and coaches who are great leaders and instill deep loyalty.

2. Define "coaching styles" and identify five types of coaching styles.
   The overall approach a coach takes in training an athlete and his or her preferred training methods. Five types of coaching styles are authoritarian, business-like, "nice guy/gal," "intense," and "easy-going."

3. What are some important points to keep in mind when coaches work with children in sports?
   Coaches need to understand the stages of human growth and development and the phases of skill acquisition; effective coaching strategies must be age-appropriate and designed to ensure an enjoyable experience for athletes at all ages and stages of development.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions:

1. Research any three famous athletes who have benefitted from using mental fitness strategies, and explain how they used sport psychology to their advantage.

2. Imagine you are a coach who has been hired to work with a top-level athlete who has recently been feeling unmotivated or "burned out." Outline the steps you would take in working with the athlete to try to overcome this impediment to his or her performance.
11.1 Types of Forces and Newton's Laws

All of our bodily movements can be understood in the context of external and internal forces and Newton's three universal laws of motion. Biomechanics can be defined as the application of Newton's laws to human movement.

(A) Fill in the Blanks

MISSION: Fill in the correct term from those provided here. Some terms may be used more than once.

minimize imbalance acceleration internal direction inertia external equilibrium magnitude maximize

1. A force is any influence, internal or external, that causes an object or a body to undergo movement, or a change in movement or ___direction___.

2. Because forces have both ___magnitude___ and direction, they are known as vector quantities.

3. All observed movement results from a(n) ___imbalance___ of forces acting on a body.

4. In the study of human motion, there could be any number of forces, both ___internal___ and ___external___, acting at any given time and in any given situation.

5. To move proficiently or help others do the same, we need to understand how to ___maximize___ the benefits of forces and at the same time ___minimize___ their potential harmful effects, such as injuries.

6. A swimmer encounters water resistance while performing a front crawl in a pool. Water resistance is an example of a(n) ___external___ force.

7. In biomechanics, the human body is regarded as a system and any force exerted by one part of the body on another, for example, when a muscle contracts to move a joint, is a(n) ___internal___ force.

8. The property of matter that causes an object or body to resist any changes in motion is known as ___inertia___.

9. When two objects exert equal and opposite forces against each other such that the sum of the forces when added together equals zero, the two objects are said to be in a state of ___equilibrium___ and no motion is observed.

10. The rate at which the velocity of an object changes over time is known as ___acceleration___.

(B) True or False?

MISSION: Circle whether each statement is True (T) or False (F).

1. Newton's first law of motion, also known as the law of inertia, applies only when an object is in a stationary position and not when an object is in a state of motion. F

2. The more mass an object has, the greater its inertia and the more effort it will take to cause the object to move or to stop moving. T

3. According to Newton's second law of motion, if a small force is applied to an object, the object will experience a large change in its velocity (the rate at which it is moving). F

4. The acceleration experienced by a ping pong ball and a tennis ball to which a force of equal magnitude is applied will differ because the two objects differ in volume. F

5. When a basketball rests motionless on a gymnasium floor, the floor exerts an unequal and opposite force upward on the basketball. F

6. When a speedskater pushes off at the start of a race, the surface of the ice exerts a force that is equal and opposite in magnitude to the force applied by the skater. T
**Newton’s Three Laws of Motion**

**Mission**: In the table below, write Newton’s three laws of motion in the first column and an example of a physical activity or sport that demonstrates each law in the second column. In the third column, write a brief rationale explaining how each physical activity or sport demonstrates that particular law of motion.

<table>
<thead>
<tr>
<th>Newton’s Law</th>
<th>Physical Activity or Sport</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The First Law of Motion</strong> (Inertia):</td>
<td>ymph activity or sport that demonstrates each law in the second column. In the third column, write a brief rationale explaining how each physical activity or sport demonstrates that particular law of motion.</td>
<td>Newton’s first law of motion applies when an object or a body maintains a stationary position. The gymnast is in a state of rest and will remain in that state unless acted upon by an external force. If the curling rock were sliding on a frictionless surface, it would continue to move indefinitely as long as no other forces acted upon it. This tendency for an object’s state of motion to remain unchanged is known as inertia.</td>
</tr>
<tr>
<td>A body in motion tends to stay in motion or a body at rest tends to stay at rest unless acted upon by an external force.</td>
<td>Gymnastics: a gymnast maintains a stationary pose on a balance beam. Curling: a curling rock is released from the hand of the curler</td>
<td>Newton’s first law of motion applies when an object or a body maintains a stationary position. The gymnast is in a state of rest and will remain in that state unless acted upon by an external force. If the curling rock were sliding on a frictionless surface, it would continue to move indefinitely as long as no other forces acted upon it. This tendency for an object’s state of motion to remain unchanged is known as inertia.</td>
</tr>
<tr>
<td><strong>The Second Law of Motion</strong> (Acceleration):</td>
<td>Tennis: a player strikes a ball with a racquet. Football: a lineman pushes a blocking sled forward</td>
<td>If the tennis player applies a large force to the ball, the ball will experience a large change in the rate at which it is moving—in other words, it will accelerate faster. The change in velocity will be proportional to the applied force. Newton’s second law applies as well to a football lineman pushing a blocking sled forward. As more mass is added to the blocking sled, the lineman must generate more force for the sled to accelerate at the same rate. Suppose the same amount of force is applied to both the tennis ball and the blocking sled. The acceleration of the tennis ball and the blocking sled will differ because the two objects differ in mass. Acceleration will be inversely proportional to the object’s mass.</td>
</tr>
<tr>
<td>A force applied to an object causes an acceleration of that object of a magnitude proportional to the force and in the direction of the force, but inversely proportional to the object’s mass. In other words, F = ma.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The Third Law of Motion</strong> (Reaction):</td>
<td>Sprinting: runner responds to the starter’s signal and pushes against the starting blocks. Basketball: a player jumps to make a slam dunk.</td>
<td>When an applied push-off force is exerted by a sprinter at the starting blocks, the blocks generate a reaction force that is equal and opposite in magnitude and direction to the force applied by the sprinter’s foot. The basketball player’s action of pushing against the court floor leads to a reaction force that is equal and opposite in magnitude and direction—the floor pushes back, and, ultimately, the player’s body leaves the ground.</td>
</tr>
<tr>
<td>For every action, there is an equal and opposite reaction.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11.2 Levers in the Human Body

A lever in the human body consists of a rigid structure (e.g., a long bone) that rotates about a fixed point or fulcrum (a joint). The distances of the load and the effort from the fulcrum affect the type of movement that takes place.

(A) Types of Levers

MISSION: Complete the information below for each class of lever. Draw a diagram in each box provided.

First Class Lever
The applied force or effort (E) and the load or resistance (R) are located on opposite sides of the fulcrum (F). Provides a force advantage or a speed advantage, depending on where the fulcrum is located.

Diagram of a first class lever:

F = Fulcrum
E = Effort (or Force)
R = Resistance

Everyday example of a first class lever: Tester-totter
Example of a first class lever in the human body: Neck extension

Second Class Lever
The resistance or load (R) is between the fulcrum and the applied force or effort (E). Provides a force advantage.

Diagram of a second class lever:

F = Fulcrum
E = Effort (or Force)
R = Resistance

Everyday example of a second class lever: Wheelbarrow
Example of a second class lever in the human body: Calf raise

Third Class Lever
The applied force or effort (E) is located between the fulcrum (F) and the load or resistance (R). Tends to provide a speed advantage rather than a force advantage.

Diagram of a third class lever:

F = Fulcrum
E = Effort (or Force)
R = Resistance

Everyday example of a third class lever: Snow shovel
Example of a third class lever in the human body: Biceps curl using a dumbbell
(B) Levers and Human Movement

**MISSION:** Each of the bodily movements listed below involves the action of a lever. For each movement, use words or sketches to identify the relative positions of the effort force (E), the fulcrum (F), and the resistance or load (R). In the first column, identify which class of lever is involved in each movement.

<table>
<thead>
<tr>
<th>Movement</th>
<th>Effort Force (E)</th>
<th>Fulcrum / Axis (F)</th>
<th>Resistance (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee extension</td>
<td>Quadriceps</td>
<td>Knee joint</td>
<td>Lower leg</td>
</tr>
<tr>
<td>Class of lever: <strong>3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder adduction</td>
<td>Deltoid</td>
<td>Shoulder joint</td>
<td>Arm</td>
</tr>
<tr>
<td>Class of lever: <strong>3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow extension</td>
<td>Triceps</td>
<td>Elbow joint</td>
<td>Forearm/hand</td>
</tr>
<tr>
<td>Class of lever: <strong>3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip extension</td>
<td>Gluteus maximun</td>
<td>Hip joint</td>
<td>Leg</td>
</tr>
<tr>
<td>Class of lever: <strong>3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scapular elevation</td>
<td>Levator scapulae (with the help of trapezius)</td>
<td>Acromioclavicular joint (AC joint)</td>
<td>Scapula</td>
</tr>
<tr>
<td>Class of lever: <strong>3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11.3 Types of Motion

Biomechanists classify the motion of a body or an object as predominantly either "linear" or "angular." Human movement that is a combination of both linear and angular components is referred to as "general motion."

(A) Distinguishing Types of Motion

**MISSION:** Complete the table below to demonstrate your understanding of the ways in which biomechanists categorize types of motion.

Classify each movement or action listed in the table as involving predominantly linear motion or predominantly rotational motion (check one or the other). Provide a brief rationale for each of your classifications in the appropriate cells of the table.

<table>
<thead>
<tr>
<th>Movement or Action</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A diver twists in the air after jumping off a diving board. <strong>Primarily:</strong></td>
<td>Angular motion features a rotation, or turning, about an axis. The diver's entire body is rotating about the antero-posterior axis.</td>
</tr>
<tr>
<td>□ Linear</td>
<td></td>
</tr>
<tr>
<td>✓ □ Angular</td>
<td></td>
</tr>
<tr>
<td>2. A ski jumper slides down a run in a crouched position. <strong>Primarily:</strong></td>
<td>The skier's body demonstrates primarily linear or straight-line motion because the skier is moving the same distance, in the same direction, in the same amount of time.</td>
</tr>
<tr>
<td>✓ □ Linear</td>
<td></td>
</tr>
<tr>
<td>□ Angular</td>
<td></td>
</tr>
<tr>
<td>3. A ballet dancer performs a pirouette. <strong>Primarily:</strong></td>
<td>The ballet dancer's pirouette involves primarily angular motion because her entire body is rotating about an axis, i.e., her body's longitudinal axis.</td>
</tr>
<tr>
<td>✓ □ Linear</td>
<td></td>
</tr>
<tr>
<td>□ Angular</td>
<td></td>
</tr>
<tr>
<td>4. A basketball player pivots on one foot to make a pass. <strong>Primarily:</strong></td>
<td>The basketball player's pivot involves primarily angular motion because this action involves the player's body turning through an angle, or number of degrees, in this case, a quarter turn, or 90 degrees.</td>
</tr>
<tr>
<td>✓ □ Linear</td>
<td></td>
</tr>
<tr>
<td>□ Angular</td>
<td></td>
</tr>
<tr>
<td>5. A bowler approaches the foul line prior to rolling the ball. <strong>Primarily:</strong></td>
<td>The movement of stepping forward involves primarily linear or straight-line motion because the body moves the same distance, in the same direction, in the same amount of time.</td>
</tr>
<tr>
<td>✓ □ Linear</td>
<td></td>
</tr>
<tr>
<td>□ Angular</td>
<td></td>
</tr>
<tr>
<td>6. A four-man bobsled team begins its slide down a track. <strong>Primarily:</strong></td>
<td>The bobsled's motion is primarily linear because the sled is travelling the same distance, in more or less the same direction, in the same amount of time.</td>
</tr>
<tr>
<td>✓ □ Linear</td>
<td></td>
</tr>
<tr>
<td>□ Angular</td>
<td></td>
</tr>
</tbody>
</table>
(B) Understanding Rotational Motion

MISSION: Answer the questions below to demonstrate your understanding of rotational motion and the kind of force that produces rotational motion.

Describe three different ways in which human physical activities can involve rotational (or angular) motion. You can give some examples from your own experience of these three kinds of rotational motion.

1. Rotations of projectiles or other objects, e.g., a tennis ball exhibiting a "spin."

2. Rotations of the entire human body about one of three axes, e.g., an athlete performing a hammer throw involves rotation about the longitudinal axis of the athlete's body.

3. Rotations of individual body segments, e.g., the upper arm rotates at the shoulder joint when a baseball is thrown.

4. Which characteristic of a force determines whether or not the object to which the force is applied will undergo rotational motion? Draw two simple labelled diagrams in the spaces below to support your answer.

   It is the point of application of a force that determines the type of motion that the object or body acted upon by the force will undergo. If a centric force is applied directly through the centre of an object or body, linear motion will result. If an eccentric (off-centre) force is directed through a point other than the centre of the object or body, then rotational motion (and sometimes linear motion) will result.

Application of an eccentric force.

Application of a centric force.
**Worksheet**

**Chapter 11 Quiz**

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 11. Complete each set of questions according to your teacher’s instructions.

**Question Set 1: Newton’s Laws of Motion and Levers in the Human Body**

### Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. An example of Isaac Newton’s first law of motion (inertia) would be:
   - (a) a basketball resting motionless on the floor
   - (b) a rock travelling endlessly into outer space
   - (c) a bowling ball rolling evenly down a lane
   - (d) all of the above

   ✓ (d) all of the above

2. According to Newton’s second law of motion (acceleration), a force applied to an object causes an acceleration of that object of a magnitude that is
   - (a) unrelated to the object’s mass
   - (b) inversely proportional to the object’s mass
   - (c) the same as the object’s mass
   - (d) directly proportional to the force itself

   ✓ (b) inversely proportional to the object’s mass

3. According to Newton’s second law of motion (stated as \( F = ma \)), the acceleration of a 0.33 kg tennis ball when a force of 10 N is applied to it will be
   - (a) 3.3 m/s\(^2\)
   - (b) 33.3 m/s\(^2\)
   - (c) 333.3 m/s\(^2\)
   - (d) 3333.3 m/s\(^2\)

   ✓ (b) 33.3 m/s\(^2\)

4. An example of Newton’s third law of motion (action-reaction) would be
   - (a) a diver pushing off a diving platform
   - (b) a basketball player jumping up to take a shot
   - (c) a kettlebell resting on a gymnasium floor
   - (d) all of the above

   ✓ (d) all of the above

5. A mechanical device where the force is applied between the fulcrum and the load is a
   - (a) first class lever
   - (b) second class lever
   - (c) third class lever
   - (d) none of the above

   ✓ (c) third class lever

6. Plantarflexion is an example of a
   - (a) first class lever
   - (b) second class lever
   - (c) third class lever
   - (d) none of the above

   ✓ (d) none of the above

### Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. Define the term “biomechanics.”
   Biomechanics is the branch of kinesiology that seeks to understand the behavior and function of the living human body when it is acted upon by forces.

2. What is meant by the phrase “movement proficiency”?
   Movement proficiency involves proficient movement patterns—ones that minimize energy expenditure while facilitating human performance.

3. Name the four components of a lever, list each type of lever, and state what general advantage each type of lever provides.
   - The axis (fulcrum), the lever arm, the load, and the effort
   - First class lever (teeter-totter)—force or speed advantage
   - Second class lever (wheelbarrow)—force advantage
   - Third class lever (squash racquet)—speed advantage

### Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Explain, with examples, how external and internal forces can either help or hinder movement, depending on the context.

2. Discuss whether you think understanding Newton’s laws of motion is essential in understanding human movement and sport.

3. Identify and describe a bone-muscle-joint configuration that represents a third-class lever. Sketch this configuration and label the fulcrum, the load, and the effort.
Question Set 2: Types of Motion and Applied Biomechanics

Multiple-Choice Questions

MISSON: Circle the letter beside the answer that you believe to be correct.

1. Motion that takes place when a body or its collective parts moves the same distance in the same direction in the same amount of time is known as
   (a) rectilinear motion
   (b) translational motion
   (c) linear motion
   ✓ (d) all of the above

2. The linear motion of humans is generally a result of the interaction of
   ✓ (a) a combination of forces
   (b) a combination of diagonal movements
   (c) a combination of forward movements
   (d) none of the above

3. Generally, a force acting through the centre of an object or body will cause the object or body to
   (a) rotate clockwise
   (b) rotate counterclockwise
   (c) rotate sideways
   ✓ (d) move in a straight line

4. The turning effect produced by an eccentric force applied to a body at some distance from an axis of rotation is known as
   (a) velocity
   (b) angular motion
   (c) the resultant force
   ✓ (d) torque

5. Human movement is usually a combination of linear and rotational motion and is called
   (a) resultant motion
   ✓ (b) general motion
   (c) accelerated motion
   (d) projectile motion

6. Ergonomists match these human characteristics to specific activities.
   (a) cognitive and psychological
   ✓ (b) anatomical, physiological, and biomechanical
   (c) musculoskeletal and neurological
   (d) none of the above

Short-Answer Questions

MISSON: Briefly answer the following questions in the space provided:

1. List three different ways in which human physical activity can involve rotational or angular motion.
   Rotations of projections or other objects; rotations of the entire human body about one of the three axes; rotations of individual body segments.

2. How can linear movements such as walking and running involve angular motion as well?
   Linear movements like walking and running depend on the rotational motion of each body segment (e.g., foot, lower leg, and thigh) of an athlete's limbs as they rotate around the joints.

3. Distinguish between a centric and an eccentric force. What is the result of each type of force?
   A centric force is applied directly through the centre of an object or body and it results in linear motion only. An eccentric (off-centre) force is directed through a point other than the centre of the object or body and it always results in rotational motion (and sometimes linear motion, too).

Essay Questions

MISSON: On a separate piece of paper, develop a 100-word response to the following questions.

1. Explain what determines which type of motion occurs when a force is applied to a stationary object or body.

2. Define the term "ergonomics" and give examples of everyday devices to which ergonomic thinking has been applied.

3. Biomechanics is an "applied science." What are some areas in which biomechanics would have practical uses? Give several examples of career paths related to biomechanics.
12.1 The Seven Principles of Biomechanics: Anchor Chart

You can begin to understand movement dynamics and biomechanical analysis through the seven biomechanical principles set forth by the Coaching Association of Canada's National Coaching Certification Program (NCCP).

MISSION: As you read through Chapter 12 in your textbook, demonstrate your understanding of the seven principles of biomechanics by completing the table below as you progress through the chapter.

- The biomechanical principle is stated for you in the first column of the table.
- In the second column, rewrite the principle in your own words. If you like, create a simple sketch or diagram to help you understand each principle.
- In the third column, describe, in point form, one or more activity-specific or sport-specific example(s) of the principle in action.

<table>
<thead>
<tr>
<th>Biomechanical Principle</th>
<th>Restated In Your Own Words</th>
<th>Example(s) of Principle in Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle 1: Stability</td>
<td></td>
<td>A three- or four-point stance in football lowers the player's centre of mass in relation to the base of support. In wrestling, a wrestler tends to adopt a wide stance to increase his or her base of support.</td>
</tr>
<tr>
<td>Principle 2: Production of Maximum Force</td>
<td>The production of maximum force requires the use of all possible joint movements that contribute to the task's objective.</td>
<td>100-m sprint: running as fast as possible requires full joint rotations at the ankle, knee, and hip joints to produce maximum force. A baseball batter first steps toward the oncoming ball and then rotates the hips before swinging the bat fully using the shoulders, arms, and wrists.</td>
</tr>
<tr>
<td>Principle 3: Production of Maximum Velocity</td>
<td>The production of maximum velocity requires the use of joints in order—from largest to smallest.</td>
<td>When a baseball is thrown, joint actions are sequenced, beginning with movement in the larger joints (in the legs and hips), followed by movements in the smaller joints—in the arms, the elbows, and the wrists. A golfer's swing is precisely sequenced: first leg, then hip, and finally arm action.</td>
</tr>
<tr>
<td>Principle 4: The Impulse-Momentum Relationship</td>
<td>High jumpers performing a Fosbury Flop arch their neck and back and push against the ground to create a stronger impulse force to help them clear the bar. Volleyball players executing a jump serve lob the ball forward and then run and jump into the air in order to “spike” the ball to the opposing team. The forward running motion of the server’s body transfers momentum to the ball, thus increasing its velocity.</td>
<td></td>
</tr>
<tr>
<td>Movement usually occurs in the direction opposite that of the applied force.</td>
<td>In making a cut in ultimate or soccer, a player will push his or her foot against the ground to make a change in direction away from an opponent. Swimmers apply principle 5 when making a flip turn; they turn and push against the wall of the pool with their legs in order to propel their bodies forward.</td>
<td></td>
</tr>
<tr>
<td>Principle 5: Direction of Force Application</td>
<td>Importing “top-spin” to a tennis ball requires using an upward stroke against the ball, i.e., hitting it “off-centre.” If a rugby player is standing tall, a force applied by an oncoming opponent to the player’s body will likely produce enough torque to knock her off her feet.</td>
<td></td>
</tr>
<tr>
<td>Angular motion is produced by the application of a force acting at some distance from an axis; that is, by torque.</td>
<td>Principle 6: Production of Angular Motion (Torque)</td>
<td></td>
</tr>
<tr>
<td>Principle 7: Conservation of Angular Momentum</td>
<td>Trampoline, figure skating, gymnastics, and high diving are all activities that require fast spinning action. The speed of the spin is controlled by adjusting the position of the arms and legs in relation to the axis of rotation of the athlete’s body. Pulling the arms and legs in closer to the body adjusts how far the athlete’s mass is distributed from the axis of rotation, and the rotation speeds up. To slow the rate of rotation, the athlete simply extends the arms and legs away from the axis of rotation.</td>
<td></td>
</tr>
</tbody>
</table>
12.2 Principle 1: Stability

The ability to maintain one's balance is crucial in almost every physical activity or sport. Biomechanical principle 1 applies whether you are on a sidewalk, a skateboard, a bike, a balance beam, or a football field.

MISSION 1: Assume each of the following positions and determine their relative stability by having your partner push you gently and continuously with two hands on the anterior part of your shoulders to try to upset your balance. Then, answer the questions that follow.

(a) standing upright on one foot
(b) standing upright on two feet, feet together
(c) standing upright on two feet, feet shoulder width apart
(d) standing upright on two feet with weight displaced forward, leaning with both hands on a metre stick placed about two-thirds of a metre in front of you (like a cane held with both hands)
(e) standing upright on two feet with weight displaced forward, leaning on a chair
(f) standing upright on two feet, feet placed one foot in front of the other about one metre apart

1. Which position is the most stable, relatively speaking? Explain your observations.

(f) This position is the most stable.
It features the largest base of support and for this reason a relatively large force would be required to move you in order to upset your balance.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. Which position is the least stable, relatively speaking? Explain your observations.

(a) Standing on one foot decreases the size of your base of support considerably.
This means that a relatively small force would be required in order to move you to upset your balance.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
MISSION 2: Repeat positions (a) to (f) on the previous page, but this time have your partner push you gently from the lateral side of your shoulder when you assume each position.

Answer the following questions:

1. Which position is the most stable, relative to the other positions? Explain your observations.

   (f) See answer on previous page. How stable or unstable an individual is always depends on the four factors described in biomechanical principle 1: mass, centre of mass, base of support, and the position of the centre of mass.

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

2. Which position is the least stable, relative to the other positions? Explain your observations.

   (a) How stable or unstable an individual is always depends on the four factors described in biomechanical principle 1: mass, centre of mass, base of support, and the position of the centre of mass.

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

3. Describe three specific examples in sport where the base of support and stability (or a lack of stability) can benefit performance.

   (a) In gymnastics, an athlete’s base of support and stability are important in order to “stick” a landing.

   (b) In football, a defensive lineman pushing off a line puts himself in an instable position in order to tackle an opponent.

   (c) Rock climbers open their legs and crouch a bit when they reach to the right or left to find a hand hold so that their centre of mass is low enough that it will not move outside the base of support, which would otherwise lead to instability and a fall.

MISSION 3: Stand up, bend from the waist, and touch your toes without bending your knees. Now, repeat these actions, but this time stand with your gluteus maximus and both of your calcaneous touching the wall. What result do you observe?

Why do you think this is the case? (Relate your observations to the centre of gravity, the line of gravity, and the base of support.)

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

   It is not possible to touch your toes in the second position because you must lean slightly forward and then your line of gravity falls outside your base of support. Such a situation always lead to an unstable position.
### WORKSHEET

#### 12.4 Principles 4 and 5: Linear Motion

According to biomechanical principle 4, the greater the applied impulse, the greater the increase in velocity. Biomechanical principle 5 states that movement usually occurs in the direction opposite that of the applied force.

<table>
<thead>
<tr>
<th>Important Concepts to Help You Complete This Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Linear motion is movement in a straight line.</td>
</tr>
<tr>
<td>• Momentum refers to the amount of motion developed by an athlete (or object).</td>
</tr>
<tr>
<td>• Linear momentum is the amount of momentum developed by an object or body moving in a straight line, a quantity that can be calculated by multiplying the mass of the athlete (or object) by its velocity.</td>
</tr>
<tr>
<td>• Impulse refers to the application of force over a period of time that results in a change in momentum.</td>
</tr>
<tr>
<td>• Movement usually occurs in the direction opposite that of the applied force.</td>
</tr>
</tbody>
</table>

**MISSION:** Perform and compare the following three sprint start positions as they relate to the maximal applied force (biomechanical principle 4), the direction of the applied force (biomechanical principle 5), and the resultant force (i.e., the movement outcome or performance). Sketch each position in the second column of the chart, using coloured arrows to indicate the “applied force direction” of the sprinter (you) and the “reaction force direction” of the ground. (Use one colour for the applied force direction and another colour or your choice for the reaction force direction.) Be sure to indicate the angle of each force accurately when drawing it.

In the third column of the chart, describe in point form one or more activity-specific or sport-specific example(s) of the biomechanical principle in action.

<table>
<thead>
<tr>
<th>Start Position</th>
<th>Sketch</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standing start</strong>&lt;br&gt;Body upright, both feet on the ground, knees slightly bent</td>
<td></td>
<td>A “block jump” in volleyball.</td>
</tr>
<tr>
<td><strong>Crouching start</strong>&lt;br&gt;Back positioned at a 45 degree angle, knees bent, front foot flat, back foot heel up</td>
<td></td>
<td>A “shoot position” in wrestling.</td>
</tr>
<tr>
<td><strong>Block start</strong>&lt;br&gt;Body bent over, fingers on ground, both heels off ground</td>
<td></td>
<td>A football lineman’s stance.</td>
</tr>
</tbody>
</table>
MISSION: Answer the following questions related to biomechanical principles 4 and 5.

1. Identify and explain which of Newton’s laws is applied in the performance of each of the sprint starts.

   Standing start
   All of Newton’s laws apply of course, but especially the law of Action-Reaction in these cases. In terms of the seven biomechanical principles, Principle 1 (stability), Principle 4 (impulse-momentum relationship), and Principle 5 (direction of application of applied force) are also relevant. Encourage students to elaborate on how these laws and principles apply.

   Crouching start
   See notes above.

   Block start
   See notes above.

2. Decide whether your results support biomechanical principle 4: “The greater the applied impulse, the greater the increase in velocity.” Explain your answer.

   The impulse-momentum relationship states that the greater the applied impulse, the greater the increase in velocity.

3. How do starting blocks aid a sprinter? (Hint: Think about balance, gravity, and line of gravity.)

   Starting blocks are a device used in track and field by sprint athletes to hold their feet at the start of a race so they don’t slip as they push out at the sound of the gun. For most levels of competition, including all high-level international competition, starting blocks are now mandatory equipment for the start of sprint races. They help the sprinter maintain balance at start-off and ensure that each sprinter’s line of gravity is appropriately positioned to maximize applied force on push-off.

4. List two sports with which you are familiar and in which the direction of force application and/or impulse are important. Identify in which direction the force is being applied to cause the resultant motion. Explain whether your observations support biomechanical principle 5, which states that movement usually occurs in the direction opposite that of the applied force.

   (a) 

   (b) 

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12.5 Principles 6 and 7: Angular Motion

Angular (or rotational) motion is movement around an axis. Our joints serve as axes of rotation for the movement of our limbs. The entire human body can also rotate freely as it moves about one (or more) anatomical axes.

Name: ____________________________

Date: ____________________________

Principle 6: The Production of Angular Motion (Torque)
If an eccentric or "off-centre" force is applied to a body or an object, the force tends to make the body rotate about its axis. This turning effect is known as torque. When a force is applied at some distance from an axis, the turning effect—or torque—results in angular motion.

MISSION: With biomechanical principle 6 in mind, answer questions 1 to 7 below by choosing the correct key term from the ones provided. Terms can be used more than once.

<table>
<thead>
<tr>
<th>joints</th>
<th>length of the lever arm</th>
<th>vertical</th>
<th>opponent</th>
<th>horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>angle at which the force is applied to the lever arm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>axis</td>
<td>force</td>
<td>magnitude of the applied force</td>
<td>torque</td>
</tr>
</tbody>
</table>

1. Angular motion is the circular motion that occurs about a(n) ___axis___ of rotation.

2. The application of a __force__ acting at some distance from an axis of rotation produces angular motion.

3. The human body is usually described as having three main axes: a __vertical__ axis running through the centre of the body from head to toe (the longitudinal axis); a __horizontal__ axis passing from side to side through the centre of the body; and another __horizontal__ axis that passes from back to front (the anteroposterior axis).

4. The segments of our bodies have many axes of rotation that permit the movement of our limbs; these axes are known as ___joints___.

5. In some sports such as rugby or football, a(n) __opponent__ imparts an off-centre force in the form of body contact.

6. If the __torque__ generated at any point of a movement places excessive strain on a tendon, a condition known as tendinitis can result.

7. The three factors that determine the amount of torque generated when a force is applied at some distance from an object's or body's centre of mass are:
   __the length of the lever arm__, __the angle at which the force is applied to the lever arm__, and the magnitude of the applied force__.
Principle 7: The Conservation of Angular Momentum

Many physical activities and sports require individuals to control the rotation of their bodies while they are airborne and in a state of free fall. When an individual or an object is free in the air, angular momentum is constant. The law of conservation of momentum states that the total angular momentum of a rotating body remains constant if the net torque acting on the rotating body is zero.

MISSION: With biomechanical principle 7 in mind, answer the questions below.

1. In the sport of diving, the basic body positions are layout, pike, and tuck, as shown from left to right above. For each position shown, think about the angular momentum that the diver’s body generates. Angular momentum is the product of the diver’s rate of rotation (angular velocity) and the extent to which the diver’s body resists angular motion (the moment of inertia). The farther a body’s distribution of mass is from the axis of rotation, the greater the body’s moment of inertia (resistance to angular motion). Taking biomechanical principle 7 into account, determine in which position the diver will rotate most rapidly. Explain your thinking.

   Layout: The diver’s rate of rotation is decreased just before entry into the water because straightening out into a layout position maximizes the moment of inertia (resistance to angular motion).

   Pike: The moment of inertia is decreased when the diver brings her arms and legs in closer to her axis of rotation, thus increasing her rate of rotation.

   Tuck: The diver rotates most rapidly in this position because the moment of inertia is minimized when she pulls her arms and legs very close to her axis of rotation.

2. In order to achieve the most success once an athlete becomes airborne, when must rotation be initiated? Explain your thinking in terms of biomechanical principle 7.

   Before initiating a rotation, a trampolinist bounces straight up and down in order to gradually reach a maximum height that will allow him or her to complete complex rotational stunts. Only when an airborne athlete reaches the desired height will he or she introduce rotations. A greater height allows more rotations before the athlete must extend arms and legs in order to slow the rate of rotation before landing.

3. During a dismount from a balance beam, a gymnast attempts to complete as many longitudinal rotations as possible before landing feet first on the mat. (a) What is the best way for the gymnast to initiate the twisting motion? Explain your thinking. (b) How should the gymnast’s body be positioned in order to twist most efficiently? Explain your thinking.

   (a) By maximizing angular momentum, and therefore speed of rotation, by pulling arms in towards the centre of the body;

   (b) Keep arms and legs very close to the body’s longitudinal axis of rotation in order to decrease the moment of inertia.

4. A common mistake that aerial skiers make when doing difficult tricks is to over-rotate and miss the landing. This mistake can potentially lead to an accident and serious bodily injury. Think about how a coach could explain biomechanical principle 7 to an aerial skier in order to help prevent the skier from being injured. Then answer these questions: (a) How is angular motion generated, and how could it have both positive and negative outcomes in the execution of an aerial trick? (b) How can aerial skiers control their rate of rotation once airborne? (Hint: Consider the potential rotation of a skier’s body in all planes.)

   (a) Angular motion is generated when movement occurs around an axis; if the skier carefully controls the speed of his or her angular motion, the trick will be successful; if the skier does not control the speed of angular motion, it will be either too slow or too fast, the trick may fail.

   (b) They can control their rate of rotation by adjusting their moment of inertia through careful positioning of their arms and legs to either increase or decrease the distance of their body’s distribution of mass from their axis of rotation.
### 12.6 Applying the Seven Principles of Biomechanics

Understanding and applying the seven principles of biomechanics can lead to improved motor skills, enhanced athletic performance, and reduced injuries and accidents at work sites.

**Name:** __________________________

**Date:** __________________________

**MISSION:** Perform each lab activity with a partner (or in a small group) and answer the accompanying “Biomechanically Speaking ...” reflection question. Then identify which of the seven principles of biomechanics applies to each lab activity, and be sure to use each principle only once. A sample entry is provided below.

Equipment needed: Clothing and footwear appropriate for physical education class, basketballs, measuring tape, pylons, footballs, and floor hockey sticks and balls.

<table>
<thead>
<tr>
<th>Lab Activity</th>
<th>Biomechanically Speaking...</th>
<th>Biomechanical Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand with your feet together while your partner gently pushes against your shoulder.</td>
<td>... what can you do to be more stable and resist falling over? Lower my centre of mass—either by bending my knees or spreading my feet apart more.</td>
<td>Principle #1: STABILITY: The greater the mass, the lower the centre of mass to the base of support; the larger the base of support, and the closer the centre of mass is positioned to the base of support, the more stability increases.</td>
</tr>
<tr>
<td>1. Stand behind the foul line and, using only your shoulder, elbow, and wrist joints, try to get a basketball in the basket.</td>
<td>... what do you need to do reach the basket more easily? Use my joints in order—from largest to smallest, i.e., sequence my joint rotation starting with the shoulder, then the elbow, and then the wrist.</td>
<td>Principle #3: PRODUCTION OF MAXIMUM VELOCITY: The production of maximum velocity requires the use of all joints in order—from largest to smallest.</td>
</tr>
<tr>
<td>2. Run as fast as you can for about 20 metres with your arms pressed against your sides.</td>
<td>... what do you need you do to run faster and more efficiently? Run with my elbows bent in order to allow for full joint rotation of the hip joints; restricting joint range of motion at the ankle, knee, or hip joints will mean that fewer joints and muscles are contributing to the desired movement and therefore less force will be produced.</td>
<td>Principle #2: PRODUCTION OF MAXIMUM FORCE: The production of maximum force requires the use of all possible joint movements that contribute to the task’s objectives.</td>
</tr>
<tr>
<td>3. Using a floor hockey stick and ball, attempt a slapshot using only a 30 cm wind-up.</td>
<td>... what do you need to do to make the slapshot more effective? Use a longer wind-up in order to apply the force over a longer period of time—thus increasing not only the pushing force or impulse that I apply to the ball but also the ball's velocity.</td>
<td>Principle #4: IMPULSE-MOMENTUM RELATIONSHIP: The greater the applied impulse, the greater the increase in velocity.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4. Throw a perfect spiral with a football.</td>
<td>... what forces are preventing the ball from spiraling forever? The external forces of gravity and friction (air resistance) prevent the ball from spiraling forever.</td>
<td>Principle #6: PRODUCTION OF ANGULAR MOMENTUM: Angular motion is produced by the application of a force acting at some distance from an axis (that is, by torque). Principle #7: CONSERVATION OF ANGULAR MOMENTUM: Angular momentum is constant when an individual or object is free in the air.</td>
</tr>
<tr>
<td>5. Perform a modified or standard push-up slowly.</td>
<td>... what do you need to do to perform a “hand-clap” push-up? First push downward on the floor with all my might and then push off the floor so that I reach a height above the floor sufficient to allow me to quickly clap my hands.</td>
<td>Principle #5: DIRECTION OF APPLICATION OF THE APPLIED FORCE: Movement usually occurs in the direction opposite that of the applied force.</td>
</tr>
<tr>
<td>6. In your stocking feet, spin on one foot, keeping your arms away from your body.</td>
<td>... what can you do with your arms to spin faster while twirling? I can pull my arms in closer to my body. This will decrease the moment of inertia and therefore my rate of rotation will increase because by bringing my arms in close to my body, I am decreasing the distance of my body’s distribution of mass from my axis of rotation. If my moment of inertia decreases, my angular velocity (rate of spinning) must increase because angular momentum will remain constant.</td>
<td>Principle #7: CONSERVATION OF ANGULAR MOMENTUM: Angular momentum is constant when an individual or object is free in the air.</td>
</tr>
</tbody>
</table>
**Chapter 12 Quiz**

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 12. Complete each set of questions according to your teacher's instructions.

**Question Set 1: Principle 1 (Stability) and Principles 2 and 3 (Maximum Effort)**

**Multiple-Choice Questions**

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. The branch of mechanics that studies changes in the motion of objects or bodies as a result of the actions of forces acting on them is known as
   (a) statics
   ✓ (b) dynamics
   (c) biomechanics
   (d) physics

2. How stable or balanced an individual is while performing a task depends on
   (a) the mass and the centre of mass
   (b) the base of support
   (c) the position of the centre of mass
   ✓ (d) all of the above

3. The imaginary middle point around which the mass of an object or a person is balanced is the
   (a) base of support
   ✓ (b) centre of mass
   (c) position of the centre of mass
   (d) line of gravity

4. The use of all possible joint movements that contribute to a task's objectives results in
   (a) the production of maximum speed
   (b) the production of maximum effort
   ✓ (c) the production of maximum force
   (d) the production of maximum inertia

5. The use of joints in order—from largest to smallest—results in the production of maximum
   (a) speed
   (b) acceleration
   ✓ (c) velocity
   (d) all of the above

6. When athletes "give it their all" or "go all out," they are often applying
   (a) biomechanical principle 1
   (b) biomechanical principle 2
   (c) biomechanical principle 3
   ✓ (d) both (b) and (c) are correct

**Short-Answer Questions**

**MISSION:** Briefly answer the following questions in the space provided:

1. What are the four broad categories into which the seven principles of biomechanics can be grouped?
   Stability, maximum effort, linear motion, angular motion

2. Explain the difference between a static system and a dynamic system.
   In a static system (whether moving or non-moving), the rate of change of motion of the object or body is unchanging over time. A dynamic system is one that experiences a change in the rate at which it is moving as a result of forces applied to it.

3. With regard to biomechanical principle 2, what are the consequences if full joint range of motion is restricted at a joint, e.g., due to injury or disease?
   Fewer muscles are able to contribute to the movement and therefore less force is produced.

**Essay Questions**

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions:

1. How can an understanding of biomechanical principles help movement professionals, athletes, and you yourself to improve your own or someone else's movement proficiency?

2. Use the example of a gymnast on a balance beam to explain what the gymnast can do to improve stability (biomechanical principle 1).

3. Describe how you could apply biomechanical principles 2 and 3 to improve your tennis serve, golf swing, or baseball pitch.
Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Impulse (the application of a force over a period of time) equals
   (a) mass multiplied by velocity
   (b) mass multiplied by acceleration
   (c) force multiplied by time
   (d) velocity multiplied by acceleration
   ✓ (c) force multiplied by time

2. The amount of torque generated depends on the
   (a) magnitude of the applied force
   (b) length of the lever arm (the distance from the point of application of the force and the axis)
   (c) angle at which force is applied to the lever arm
   (d) all of the above
   ✓ (d) all of the above

3. Momentum—the quantity of motion contained within an object or body—is equal to
   (a) the object’s mass multiplied by its velocity
   (b) the object’s mass multiplied by its acceleration
   (c) force multiplied by time
   (d) velocity multiplied by acceleration
   ✓ (a) the object’s mass multiplied by its velocity

4. The moment of inertia is defined as
   (a) the distribution of the mass of an object in relation to the axis of rotation
   (b) change in an object’s angular velocity
   (c) an object or body’s resistance to a change in its rate of angular rotation
   (d) an object’s change in direction of movement
   ✓ (c) an object or body’s resistance to a change in its rate of angular rotation

5. Angular velocity is
   (a) a quantitative expression
   (b) also called rotational velocity
   (c) the amount of rotation that a spinning object undergoes per unit of time
   (d) all of the above
   ✓ (d) all of the above

6. If a diver opens up from a tuck position before entering the pool, the diver’s moment of inertia
   (a) increases
   (b) decreases
   (c) neither increases nor decreases
   (d) none of the above
   ✓ (a) increases

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. Which biomechanical principle is closely related to Newton’s third law of motion?
   Principle 5: Movement usually occurs in the direction opposite that of the applied force.

2. According to biomechanical principle 6, how is angular or rotational motion produced?
   Angular motion is produced by the application of a force acting at some distance from an axis; that is, by torque.

3. When rotations are introduced into a gymnast’s routine, what is generated as a result?
   Angular momentum, which is the product of the rate at which the gymnast is rotating—or angular velocity—and the moment of inertia, i.e., the extent to which the gymnast’s body resists angular motion.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Discuss, with examples, the prevalence of biomechanical principles 4, 5, and 6 in everyday life as well as in sports.

2. Mimic a sport skill involving a predominantly rotational motion. Explain how biomechanical principles 6 and 7 apply to the successful execution of that movement.

3. Explain the concept of the conservation of angular momentum, with examples.
13.1 Qualitative Analysis

Coaches use qualitative analysis to break down a skill in order to find ways to improve proficiency in the execution of that skill.

MISSION: Complete the table using the biomechanical concepts and principles you have learned to date.

Name: ____________________________
Date: ____________________________

(A) A Slapshot in Hockey

Record and Explain: Examine the hockey slapshot sequence shown in the photographs above. Now begin to analyze the sequence using some of the biomechanical terminology you have learned.

Divide up into groups of 3-5 students. Take turns replicating the skill movement as best you can, helping others with the execution of the skill if they need it.

In the table below, using biomechanical terms, write in your observations about the mechanics of the skill through its key phases. Suggest ways that execution of a slapshot or similar skill (a tennis forehand, for example) can be improved by applying a basic understanding of biomechanical concepts and principles.

<table>
<thead>
<tr>
<th>Phase of Movement</th>
<th>Qualitative Observations Using Biomechanical Concepts and Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preliminary movements</td>
<td>The backswing is the first part of a slap shot. In this “winding up” motion, the player brings his or her stick back with the shoulder and elbow extending. During the backswing, the player’s torso rotates back to eventually achieve the swinging motion.</td>
</tr>
<tr>
<td>2. Execution</td>
<td>Execution involves a downswing—the motion of the player bringing his or her stick down towards the ice to “slap” the puck. This action imparts force to make the puck move. As the player’s stick comes through the downswing phase, he or she “slams” the stick slightly onto the ice to produce a flex in the stick, which in turn produces a greater movement of the puck. The amount of force applied to the puck can be increased by sequencing the use of the muscles of the upper arm followed by those in the forearm, and finishing with those in the wrist—thus using biomechanical principles 2 and 3 to improve execution of the skill.</td>
</tr>
<tr>
<td>3. Follow-through</td>
<td>In the release/follow-through phase of a slapshot, the player “releases” the stick from the ice and begins pointing the stick towards the direction in which he or she wants it to go. This phase is the most important because it determines the accuracy of the slapshot.</td>
</tr>
</tbody>
</table>
QUALITATIVE ANALYSIS

(B) A Soccer Kick

Record and Explain: Examine the soccer kick sequence shown in the photographs above. Now begin to analyze the sequence using some of the biomechanical terminology you have learned.

Divide up into groups of 3-5 students. Take turns replicating the skill movement as best you can, helping others with the execution of the skill if they need it.

In the table below, using biomechanical terms, write your observations about the mechanics of the skill through its key phases. Suggest ways that execution of a soccer kick or a similar skill (a punt in football, for example), can be improved by applying a basic understanding of biomechanical concepts and principles.

<table>
<thead>
<tr>
<th>Phase of Movement</th>
<th>Qualitative Observations Using Biomechanical Concepts and Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preliminary movements</td>
<td>The soccer player’s running approach toward the ball creates momentum and permits a long angular swing of her kicking leg toward the ball. If the player taking the kick is right-footed (as shown in the photo), he or she will need to plant her left foot on the ground as her right leg swings backward in preparation for the kick.</td>
</tr>
<tr>
<td>2. Execution</td>
<td>The player’s right foot swings forward and makes contact with the ball. Keeping the left foot firmly in contact with the ground will help improve the kick, because pushing down on the ground with the left foot for a period of time generates ground reaction force while also increasing impulse, which helps the soccer player impart greater force to the ball (biomechanical principles 4 and 5). Maximum velocity is imparted to the ball as a result of a series of sequenced movements, beginning with flexion at the hip joint, followed by extension at the knee, and then dorsiflexion at the ankle (biomechanical principles 2 and 3).</td>
</tr>
<tr>
<td>3. Follow-through</td>
<td>The kicking leg acts as a third class lever in propelling the ball forward toward the goal.</td>
</tr>
</tbody>
</table>
QUALITATIVE ANALYSIS
(C) A Golf Stroke

Record and Explain: Examine the golf stroke sequence shown in the photographs above. Now begin to analyze the sequence using some of the biomechanical terminology you have learned.

Divide up into groups of 3-5 students. Take turns replicating the skill movement as best you can, helping others with the execution of the skill if they need it.

In the table below, using biomechanical terms, write in some observations about the mechanics of the stroke through its key phases. Suggest ways that execution of a golf stroke or a similar skill (a backhand in tennis, for example), can be improved by applying a basic understanding of biomechanical concepts and principles.

<table>
<thead>
<tr>
<th>Phase of Movement</th>
<th>Qualitative Observations Using Biomechanical Concepts and Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preliminary movements</td>
<td>Takeoff: This is the starting point for the golf shot. After the player has set his or her position, the player must start the swing. This is challenging because the law of inertia applies to a golf swing. A body at motion tends to stay in motion; a body at rest tends to stay at rest. Thus, golfers need a &quot;trigger mechanism&quot; to get started. Many golfers use a small movement called a &quot;waggle&quot; to get their swing going. This is usually a small wiggle of the club head. Others trigger their swing with negative movement—instead of taking the club back, they move their hands forward just a few degrees and then take the club back. Upswing: Some golfers call this the &quot;backswing.&quot; During the upswing, golfers roll their hips to the rear and then allow their shoulders and arms to follow. They roll their hips as far back as they can comfortably go, and bring their arms back until their hands are at shoulder height. Their forearms and the shaft of the club should resemble the letter &quot;L&quot; when they are at the top of the upswing.</td>
</tr>
<tr>
<td>2. Execution</td>
<td>Downswing: This is the single most important phase of the golf swing because this is where contact with the ball occurs. Once again, the key to this phase is hip movement. Players should bring their hips through the swing and allow their hands to follow. The key to a successful downswing is to keep the speed of the swing consistent. Many golfers tend to slow down in this phase because they fear making mistakes and think they will have more control if they slow their swing—but this is not the case.</td>
</tr>
<tr>
<td>3. Follow-through</td>
<td>Follow-through: A successful golf swing culminates with a strong follow-through that ends with the club at shoulder height. If golfers are anxious to see the results of the shot immediately after making contact with the ball, they sometimes raise their heads and stop the swing too soon instead of finishing with the club at shoulder height.</td>
</tr>
</tbody>
</table>
QUALITATIVE ANALYSIS
(D) A Tennis Serve

Record and Explain: Examine the tennis serve sequence shown in the photographs above. Now begin to analyze the sequence using some of the biomechanical terminology you have learned.

Divide up into groups of 3-5 students. Take turns replicating the skill movement as best you can, helping others with the execution of the skill if they need it.

In the table below, using biomechanical terms, write in some observations about the mechanics of the serve through its key phases. Suggest ways that execution of a tennis serve or a similar skill (a volleyball smash, for example), can be improved by applying a basic understanding of biomechanical concepts and principles.

<table>
<thead>
<tr>
<th>Phase of Movement</th>
<th>Qualitative Observations Using Biomechanical Concepts and Principles</th>
</tr>
</thead>
</table>
| 1. Preliminary movements | The backswing of the racquet arm forms an L shape with the racquet, while the player bends his or her knees.  
The player brings the back foot together with the front foot.  
The player drops the racquet behind his or her back until the racquet head points towards the ground. |
| 2. Execution | The player's elbow goes up while the tossing arm comes down.  
The player raises and straightens his or her racquet arm to hit the ball. At the point of contact with the ball, the player's bent knees straighten and he or she pushes off the ground. A player can generate maximum force behind his or her serve by engaging all possible joints that are involved in the action through a full range of motion (biomechanical principle 2). |
| 3. Follow-through | The player's racquet arm comes down across the body towards the opposite leg.  
The back foot kicks up, then comes forward. |
13.2 Determining the Position of the Centre of Mass

The centre of mass plays an important part in biomechanical analysis, but this position can be difficult to locate precisely in the human body. The “segmentation method” is one way to estimate the location of the centre of mass.

Can a force such as gravity be considered to act through a single point in the body? The answer is “yes” and this point is called the “centre of mass.” If the object is of uniform density and shape, then this point will be in the geometric centre of the object. However, a different method must be used to compute the position of the centre of mass of the human body (which is not uniform in density or shape).

To find the position of the centre of mass of the human body, it is necessary first to determine the position of the centre of mass of each body segment. This method is referred to as the segmentation method.

Note that the position of the centre of mass of a human body need not fall within the boundaries of the body. Rather, the position is dependent upon the orientation of the arms and legs.

**MISSION:** Compute the position of the centre of mass of the diver in the photo at the top of page 213. To do this, you must first determine the position of the centre of mass of each body segment (using x- and y-coordinates). Follow these steps.

- **STEP 1:** Note that a straight line has been placed over each of the body segments: foot, shank (lower leg), thigh, trunk, head, and left and right upper arm, forearm, and hand. These lines represent a stick figure of the diver. The length of each line segment is given in column A of the table (in centimetres). We can use these lines plus some other measures to determine the position of the whole body centre of mass.

- **STEP 2:** Now, each body segment itself is not of uniform density and shape, so a percentage must be applied to each measurement of length in order to estimate the centre of mass for that segment. These percentages are entered in column B (transferred from the table on this page). Multiply the length of the line by this percentage in order to locate the point of the centre of mass for each body segment. Enter this number in column C for each segment and mark this location with a dot on each line on the photo. Plot this point starting from the correct end of the line (see table on this page).

- **STEP 3:** Once you have pinpointed all the segmental centres of mass, using the lower left corner of the photo as the origin, measure the x- and y-coordinates for each of the points. For each centre of mass, enter these x- and y-coordinates in column D and column E respectively.

- **STEP 4:** Each body segment carries a different importance in relation to the position of the whole-body centre of mass. Again, we must use a “weighting factor” that approximates the significance of each body part on the overall centre of mass. This factor is provided for you in column F. Multiply the value of each x and y coordinate by this factor and enter the values in columns G and H respectively.

- **STEP 5:** Add up the values in column G and enter this in the bottom row. Do the same for column H. Mark this point (the intersection of the x- and y-coordinates) on the photo using an “X”. This “X” represents an estimate of the position of the centre of mass for the diver using the segmentation method.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Centre of Mass Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>46% (from the top)</td>
</tr>
<tr>
<td>Trunk</td>
<td>38% (from the neck)</td>
</tr>
<tr>
<td>Upper Arm</td>
<td>51% (from the shoulder)</td>
</tr>
<tr>
<td>Forearm</td>
<td>39% (from the elbow)</td>
</tr>
<tr>
<td>Hand</td>
<td>82% (from the wrist)</td>
</tr>
<tr>
<td>Thigh</td>
<td>37% (from the hip)</td>
</tr>
<tr>
<td>Calf</td>
<td>37% (from the knee)</td>
</tr>
<tr>
<td>Foot</td>
<td>45% (from the heel)</td>
</tr>
</tbody>
</table>

These percentages were provided by Professor David Sanderson at the University of British Columbia. They can be used to estimate the segmental centres of mass. Other biomechanists may use slightly different percentages, but they will arrive at similar results.
Re-Visiting the Steps

First you need to calculate the position of the centre of mass for each body segment (enter this number in column C in the table below).

Mark a dot on each line to indicate the position of the centre of mass for each body segment. (Be sure to measure from the correct end of the line.)

Find the x- and y-coordinates for each of these points and enter them in columns D and E. Then calculate the adjusted x- and y-coordinates (columns G and H).

Add up the adjusted x- and y-coordinates and you will have the final coordinates for the whole-body centre of mass. (Answers may differ slightly depending on the exact numbers for x- and y-coordinates.)

<table>
<thead>
<tr>
<th>Body Segment</th>
<th>A (Length of the Body Segment (provided in cm))</th>
<th>B (Multiplier to find the Centre of Mass for each Segment)</th>
<th>C (Distance to Segment’s Centre of Mass (in cm) (A x B))</th>
<th>D (The x-Coordinate of Centre of Mass of the Segment)</th>
<th>E (The y-Coordinate of Centre of Mass of the Segment)</th>
<th>F (Weighting Factor for that Body Segment)</th>
<th>G (Adjusted x-Coordinate (F x D))</th>
<th>H (Adjusted y-Coordinate (F x E))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>1.7</td>
<td>.45</td>
<td>.782</td>
<td>8.9</td>
<td>4.6</td>
<td>.07</td>
<td>.623</td>
<td>.322</td>
</tr>
<tr>
<td>Trunk</td>
<td>3.2</td>
<td>.38</td>
<td>1.216</td>
<td>7.2</td>
<td>7.3</td>
<td>.51</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Right upper arm</td>
<td>2.4</td>
<td>.51</td>
<td>1.890</td>
<td>7.5</td>
<td>6.1</td>
<td>.03</td>
<td>0.225</td>
<td>0.183</td>
</tr>
<tr>
<td>Right forearm</td>
<td>1.9</td>
<td>.39</td>
<td>0.741</td>
<td>4.6</td>
<td>6.3</td>
<td>.02</td>
<td>0.092</td>
<td>0.126</td>
</tr>
<tr>
<td>Right hand</td>
<td>6.6</td>
<td>.82</td>
<td>0.492</td>
<td>3.4</td>
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<td>Thigh</td>
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<td>0.630</td>
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<td>3.1</td>
<td>.02</td>
<td>0.016</td>
<td>0.062</td>
</tr>
</tbody>
</table>

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Chapter 13. Analyzing the Efficiency of Human Movement * 213

x- and y-coordinates for the diver’s centre of mass
5.92
6.481
13.3 Measuring Human Motion

Plotting the x- and y-coordinates of joints reveals motion characteristics that can be used in the analysis of human movement.

**MISSION:** Plot the x- and y-coordinate for the hip, knee, and ankle of the right leg.

To quantify human movement for analysis, the first step is to convert visual images into numeric values. This process is called “digitizing,” which simply refers to a method of obtaining an x- and y-coordinate for each joint of interest.

On the adjacent page there are ten sequential photographs of a player kicking a soccer ball. The coordinates for each joint movement are shown.

These values can be used to create a stick figure plot of the kicking movement. Representations like this can then be used by quantitative biomechanists to gain valuable information about the nature of movement at joints (angular velocity, angular acceleration, etc.).

For this exercise, we will simply plot the kicking data. Use the bottom left corner of the graph below as your graph origin and plot the x- and y-coordinates given for each photograph. Two sample entries are included (photographs 1 and 10 are plotted). Label each stick figure with the photo number.

Note the path of each marker. The foot goes through a much larger movement than the knee and hip. In fact, the hip moves only a small amount and mostly in the forward direction. In general, most physical movement involves large motion at the end of body segments, while the joints closer to the body remain relatively stable.
<table>
<thead>
<tr>
<th>Frame</th>
<th>Hip X (mm)</th>
<th>Hip Y (mm)</th>
<th>Knee X (mm)</th>
<th>Knee Y (mm)</th>
<th>Ankle X (mm)</th>
<th>Ankle Y (mm)</th>
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<td>25</td>
<td>34</td>
<td>23</td>
<td>40</td>
<td>19</td>
</tr>
</tbody>
</table>
Chapter 13 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 13. Complete each set of questions according to your teacher’s instructions.

Question Set 1: Qualitative and Quantitative Biomechanical Analysis

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. Qualitative biomechanical analysis typically involves
   (a) data collection
   (b) mathematical analysis
   (c) near-laboratory conditions
   (d) descriptive analysis of movement
   (d)

2. Which of the following does not apply to qualitative biomechanical analysis?
   (a) little or no equipment is required
   (b) generally does not require data collection and mathematical analysis
   (c) findings can be regarded as evidence-based, authoritative, and unbiased
   (d) allows coaches to interact immediately with participants to help improve their technique
   (a)

3. Which of the following does not apply to quantitative biomechanical analysis?
   (a) hard data can be collected and analyzed using rigorous mathematical techniques
   (b) results can be verified by other analysts
   (c) findings can be regarded as evidence-based, authoritative, and unbiased
   (d) little or no equipment is required
   (d)

4. Biomechanists have analyzed Usain Bolt’s remarkable feat in the 100-metre sprint using quantitative means. They were able to determine
   (a) the amount of drag (air resistance) he encountered as he ran
   (b) how much energy he used to finish the race
   (c) the maximum power he generated as he ran
   (d) all of the above
   (d)

5. Measuring joint angles during a soccer kick using motion-capture videorecording and calculating angular velocity is an example of:
   (a) qualitative analysis
   (b) quantitative analysis
   (c) both qualitative and quantitative analysis
   (d) neither quantitative nor qualitative analysis
   (b)

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. Define the term “efficiency of movement” and give an example of an efficient movement.
   Efficiency of movement is characterized by the least amount of energy to complete a task, with the least amount of wasted energy or “energy leaks.” Example: Long-distance runners move their legs backward and forward in line with their direction of travel and avoid unnecessary side-to-side movements as they run.

2. Explain what is meant by the term “functional movement.” Movement that is a product of the world in which we live; places demands on our core musculature and nervous system; usually involves multi-directional, multi-joint movements.

3. What is the essential difference between qualitative and quantitative biomechanical analysis?
   Qualitative analysis involves describing and analyzing movements primarily by using non-numerical methods; quantitative analysis relies on the use of instruments to generate numerical data to measure and quantify the movement being observed.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Think of a sport skill that you are familiar with (e.g., a chest pass in basketball). Explain what might constitute (a) a qualitative analysis and (b) a quantitative analysis of that skill.

2. Explain how “Own the Podium” relies heavily on quantitative analysis to achieve its goals.

3. Which type of analysis (qualitative or quantitative) would you feel more comfortable using to improve your performance in a physical activity or sport? Explain your answer.
Question Set 2: Applying Biomechanical Concepts and Principles in Analyzing Human Movement

Multiple-Choice Questions

**MISSION**: Circle the letter beside the answer that you believe to be correct.

1. Which biomechanical principle would feature prominently in the case of lifting a bag of groceries off the floor?
   - (a) stability (#1)
   - (b) impulse-momentum relationship (#4)
   - (c) torque (#6)
   - (d) conservation of angular momentum (#7)

2. Which biomechanical principle would feature prominently in the case of a child beginning to walk?
   - (a) stability (#1)
   - (b) impulse-momentum relationship (#4)
   - (c) torque (#6)
   - (d) conservation of angular momentum (#7)

3. Which biomechanical principle would feature prominently in the case of a trampolinist doing a spin in the air?
   - (a) stability (#1)
   - (b) impulse-momentum relationship (#4)
   - (c) torque (#6)
   - (d) conservation of angular momentum (#7)

4. Which biomechanical principle would feature prominently in the case of screwing in a lightbulb?
   - (a) stability (#1)
   - (b) impulse-momentum relationship (#4)
   - (c) torque (#6)
   - (d) conservation of angular momentum (#7)

5. Which biomechanical principle would feature prominently in the case of pitching a ball?
   - (a) stability (#1)
   - (b) impulse-momentum relationship (#4)
   - (c) torque (#6)
   - (d) conservation of angular momentum (#7)

**Short-Answer Questions**

**MISSION**: Briefly answer the following questions in the space provided:

1. List three biomechanical concepts and/or principles demonstrated by a toddler who is learning to walk.
   - Leg strength to counter the force of gravity; wide stance at first to increase the base of support (principle 1); base of support narrows and out-teeing is reduced as child gains practice; in time, increased stride length allows greater application of force (i.e., impulse) by the foot against the ground at push-off (principle 4).

2. State the most noticeable biomechanical difference between a proficient soccer player and a beginner. Proficient players use a refined and consistent movement pattern whereas novices use a variable and inconsistent one.

3. How can a shooter increase the amount of momentum and the velocity imparted to a puck when taking a wrist shot in floor hockey?
   - By increasing the amount of impulse, or the time over which a pushing force is applied to the puck; this is done by starting the shot from a position behind the body, stepping into the shot, and applying a force as the stick moves forward until the point of release.

**Essay Questions**

**MISSION**: On a separate piece of paper, develop a 100-word response to the following questions.

1. Summarize the biomechanical concepts and principles involved when a player kicks a soccer ball.

2. Explain the importance of ground reaction force and biomechanical principle 5 in floor hockey and in a sport of your choice.

3. Describe the general benefits of computerized motion analysis for coaches, teachers, students, and athletes at all levels.
Chapter 14 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 14. Complete each set of questions according to your teacher's instructions.

Question Set 1: Nutrition Basics—Nutrients, Energy Balance, and Body Weight

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Which of the following are macronutrients?
   (a) calcium and iron
   (b) vitamins and minerals
   (c) carbohydrates, proteins, fats, and water
   (d) carbohydrates, proteins, and fats
   ✓ (c) carbohydrates, proteins, fats, and water

2. Which of the following statements are true?
   (a) micronutrients include vitamins and minerals.
   (b) micronutrients assist in energy metabolism.
   (c) micronutrients help in tissue synthesis.
   (d) all of the above
   ✓ (d) all of the above

3. Health Canada’s recommendations as to how much of each nutrient we need each day to stay healthy
   (a) are known as Dietary Reference Intakes
   (b) are known as Nutrition Facts Tables
   (c) are known as the % Daily Value
   (d) are known as Nutrient Content Claims
   ✓ (b) are known as Nutrition Facts Tables

4. Which of the following vitamins are fat-soluble?
   (a) C, D, and E
   (b) A, B, C, and K
   (c) B and C
   (d) A, D, E, and K
   ✓ (d) A, D, E, and K

5. Three factors that contribute to daily caloric need are
   (a) basal metabolic rate
   (b) calories needed to fuel activity
   (c) thermic effect of food
   (d) all of the above
   ✓ (d) all of the above

6. The Harris-Benedict equation can help estimate
   (a) the rate at which your cardiovascular system uses energy
   (b) the rate at which all your muscles, taken together, use energy on a daily basis
   (c) the amount of calories you need to consume each day
   (d) a rate of energy consumption that only applies to those who work out
   ✓ (c) the amount of calories you need to consume each day

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. What happens when we consume carbohydrates in excess amounts?
   Our bodies store the extra energy in the form of fat.

2. What is the difference between unsaturated fats and saturated fats?
   Unsaturated fats are foods that come from plant sources such as olive, peanut, and canola oils, almonds, pecans, and avocados (mono-unsaturated fats) and soybean, corn, safflower and sunflower oils (polyunsaturated fats); saturated fats such as beef, pork, and dairy foods come from animals.

3. What percentages of our daily caloric intake should come from carbohydrates, fats, and proteins?
   45-65%, 20-35%, and 10-33% respectively.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Explain the principle underlying eating well in order to maintain a healthy body weight in the context of the "energy equation."

2. Describe two common ways to establish a baseline for a weight-control program using diet and exercise.

3. Why should we limit consumption of trans fats?
Question Set 2: Nutrition and Hydration for Optimal Performance

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. The best way to lose body weight is to
   (a) follow a strict diet
   ☑ (b) increase physical activity, do some resistance training, and adjust caloric intake
   (c) limit consumption of carbohydrates
   (d) avoid foods that contain fats

2. An athlete’s diet should be
   (a) high in protein and high in fat
   (b) low in carbohydrate, low in fat, and varied
   (c) high in protein and electrolytes
   ☑ (d) high in carbohydrate, low in fat, and varied

3. A proposed internal control mechanism that tightly maintains body weight and body fat is known as
   (a) set-point theory
   (b) body composition theory
   (c) optimal nutritional intake theory
   (d) total energy expenditure theory

4. The ratio of a person’s weight to the square of his or her height is known as
   (a) Glycemic Index
   (b) Body Fat Index
   (c) Body Composition Index
   ☑ (d) Body Mass Index

5. Active individuals and athletes need to ensure
   (a) replacement of fluids throughout the day
   (b) all food group servings throughout the day
   (c) balanced meals and snacks throughout the day
   ☑ (d) all of the above

6. Roughly what percentage of fluid lost during exercise or training should active individuals and athletes try to consume?
   (a) 75 percent
   (b) 100 percent
   ☑ (c) 150 percent
   (d) 200 percent

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. What are the three components of the female athlete triad?
   Low energy availability, menstrual irregularities, and low bone mass.

2. Why is the timing of nutrient intake by athletes very important?
   Pre-exercise nutrition, during exercise nutrition, and post-exercise nutrition help ensure a steady supply of the required amounts of energy and nutrients to the body throughout the day to optimize both training and recovery.

3. What two main neurological reflexes facilitate the cooling process when our bodies produce heat through exercise?
   Reflex dilation of skin and the sweating reflex.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Outline the best approach to losing body fat without hindering your RMR.

2. Explain the different purposes of pre-exercise nutrition, during-exercise nutrition, and post-exercise nutrition.

3. What advice would you give active individuals and athletes to ensure appropriate hydration and rehydration during exercise?
15.3 Design a Personal Fitness and Wellness Program

You are now ready to design a fitness program to meet your own personal needs. As a guide, use one of the templates shown here, depending on your fitness goals (health-related fitness or performance-related fitness).

**Name:**

**Date:**

**MISSION:** Apply the F.I.T.T. principle and other training principles (found in Chapter 15 of your textbook) to design an eight-week program to suit your particular needs. Re-appraise after the eight weeks to determine improvements you have made in your fitness. The table below is for those who wish to achieve an overall improvement in their health and fitness, beginning at whatever level they find themselves. The table on the following page is for more experienced athletes who wish to design a performance-level fitness regime.

### Sample Training Program for Health-Related Fitness

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Weeks 1-8</th>
<th>Weeks 9-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity</td>
<td>3 x/wk</td>
<td>3 x/wk</td>
</tr>
<tr>
<td>Type</td>
<td>walking (or any other aerobic activity of their choice, as long as it is 50-55% of their HRR)</td>
<td>front planks, McGill crunches, backbridges, sidesteps, push-ups, hand press squats, pull-ups</td>
</tr>
<tr>
<td>Time</td>
<td>20 minutes</td>
<td>20 minutes (circuit)</td>
</tr>
<tr>
<td>Intensity</td>
<td>50-55% of heart rate reserve (HRR)</td>
<td>50-55% of 1RM</td>
</tr>
<tr>
<td>Type</td>
<td>jog, walk (or any other aerobic activity of their choice, as long as it is 60-65% of their HRR)</td>
<td>front planks, McGill crunches, backbridges, sidesteps, push-ups, hand press squats, pull-ups</td>
</tr>
<tr>
<td>Time</td>
<td>20 minutes</td>
<td>20 minutes (circuit)</td>
</tr>
<tr>
<td>Intensity</td>
<td>3 sets of 15-20 repetitions (reps)</td>
<td>3 sets of 12-15 repetitions (reps)</td>
</tr>
<tr>
<td>Type</td>
<td>Rest: 20-30 seconds</td>
<td>Rest: 30-45 seconds</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Weeks 1-8</strong></td>
<td><strong>Weeks 9-16</strong></td>
</tr>
<tr>
<td>-------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td><strong>Aerobic</strong></td>
<td><strong>Anaerobic (Resistance)</strong></td>
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<tr>
<td><strong>Sample Training Program for Performance-Related Fitness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>3-4 x/wk</td>
<td>3-4 x/wk</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>60-70% of heart rate reserve (HRR)</td>
<td>65-75% of 1RM 3-5 sets of 9-12 repetitions (reps) Rest: 45-60 seconds</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>jogging (or any other aerobic activity of their choice, as long as it is 60-70% of their HRR)</td>
<td>tubing presses, tubing pulls, medicine-ball squats, medicine-ball lunges, Bulgarian split-squats, hamstring towel-curls</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>20-30 minutes</td>
<td>60+ minutes</td>
</tr>
</tbody>
</table>
Chapter 15 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 15. Complete each set of questions according to your teacher’s instructions.

**Question Set 1: Training Principles and Methods and Factors Affecting Training**

**Multiple-Choice Questions**

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. The acronym F.I.T.T.
   (a) is widely used in fitness and sport
   (b) describes the four basic elements of any good exercise or training plan
   (c) stands for frequency, intensity, type, and time (or duration) of training
   ✔ (d) all of the above

2. The most common way to determine one’s intensity range for aerobic exercise is to compute
   (a) first the Maximal Heart Rate (MHR) and then the Target Heart Rate (THR)
   ✔ (b) first the Target Heart Rate (THR) and then the Maximal Heart Rate (MHR)
   (c) the Heart Rate Reserve
   (d) the Resting Heart Rate

3. The principle of diminishing returns is based on the fact that the improvements you gain with training
   (a) will reflect the fact that every athlete is unique
   ✔ (b) will reflect your prior level of training
   (c) will reflect the level of commitment to training
   (d) will reflect whether detraining occurs

4. Developing an overall training plan divided into distinct training periods to maximize performances at peak times is known as
   (a) sprints
   (b) high speed, explosive movements
   (c) long-distance running
   ✔ (d) periodization

5. Core training involves
   (a) the muscles that brace and stabilize your spine
   (b) the muscles of the back and abdominals
   (c) the upper limb muscles
   ✔ (d) Both (a) and (b) are correct.

6. Pliometrics training is a form of
   (a) flexibility training to decrease stress on joints
   ✔ (b) resistance training for strength and power
   (c) cardiorespiratory training to boost endurance
   (d) speed/ability/quickness training

**Short-Answer Questions**

**MISSION:** Briefly answer the following questions in the space provided:

1. What are five principles underlying all sound training programs?
   Progressive overload, specificity, individual differences, reversibility, and diminishing returns.

2. Which two general concepts should be kept in mind when devising a training plan?
   Regularity and sustainability.

3. What factors help combat fatigue in an athlete?
   Sufficient rest and recovery, and appropriate sleep routines.

**Essay Questions**

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Summarize the ingredients of a good training program and provide examples of training principles and methods in action. (Mention components identified by Canadian Sport for Life’s Long-Term Athlete Development Program that help prevent overtraining.)

2. Explain the three phases of a good cardiorespiratory training program.

3. Discuss various ways in which environmental factors can have an impact on training.
**Question Set 2: Designing an Individualized Training Program**

**Multiple-Choice Questions**

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. A person’s fitness and training goals could include
   (a) gaining muscle strength and losing weight
   (b) preparing for an elite competition
   (c) attaining a personal best in a recreational sport
   (d) all of the above

2. A safe and effective training program features both
   (a) a continuous and an interval segment
   (b) a 40-metre dash and a walk-run test
   (c) an aerobic and an anaerobic segment
   (d) an agility and a coordination segment

3. In the aerobic segment of a training program, the participant and trainer must
   (a) monitor heart rate and perceived exertion
   (b) check muscle tightness and joint soreness
   (c) provide adequate relief between sets/exercises
   (d) all of the above

4. The 2013 CSEP-PATH manual provides the latest information on
   (a) physical activity, sedentary behaviour, and fitness levels
   (b) brain research and cognitive functioning
   (c) health-related behaviour change
   (d) (a) and (c) above

5. The 5 As of CSEP’s Physical Activity Training for Health (CSEP-PATH) are
   (a) ask, appraise, analyze, alter, and accredit
   (b) ask, alert, avoid, administer, achieve
   (c) ask, answer, allow, act, adapt
   (d) ask, assess, advise, agree, assist/arrange

6. The frequency of both aerobic and anaerobic training for health-related fitness should be
   (a) once a week
   (b) three times a week
   (c) twice a week
   (d) six times a week

**Short-Answer Questions**

**MISSION:** Briefly answer the following questions in the space provided:

1. Outline the three stages involved in developing a sound individualized training program.
   Counselling to establish clear fitness objectives; gathering more detailed information through a fitness appraisal; selecting appropriate exercises/activities to fit the goal.

2. What are the benefits of warming up and cooling down during each segment of a training program?
   Warm-up: flexibility gains; first check on how the body feels before a workout; cool-down: maximum flexibility gains; opportunity to monitor overall state of the body after workout.

3. List six components of fitness for which there are standardized fitness appraisals.
   Speed and reaction; power and strength; agility and coordination; flexibility; endurance; and body composition.

**Essay Questions**

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Which factors determine what to assess and which fitness assessments are most appropriate in designing a sample training program?

2. Design a safe and effective personal anaerobic training program to suit an individual in a sport of your choice.

## 16.1 The Effects of Ergogenic Substances and Techniques

When the rewards of winning take precedent over the principle of fair play, athletes may resort to banned substances and techniques to improve their performance. Many ergogenic aids pose serious health risks, however.

**MISSION**: Use the space provided in the table below to briefly identify and describe the use and effects, as well as any health risks associated with the substances or techniques listed in the first column.

<table>
<thead>
<tr>
<th>Type of Ergogenic Substance</th>
<th>Use and Effects</th>
<th>Health Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anabolic agents</strong></td>
<td>Pill and liquid form / travel through the bloodstream and body's cells / travel to the muscles to prompt tissues in muscle to produce growth (increased lean body mass, i.e., muscle mass) / during exercise, steroid increases amount of protein sent to the muscles, which causes increases in rebuilding tissue / brings out more aggression / won't affect the body without physical exercise</td>
<td>Stunted growth / tissue injuries take longer to heal / change in blood pressure / acne / leg muscle cramping / headaches / burning during urination / liver damage / menstrual irregularities</td>
</tr>
<tr>
<td><strong>Diuretics</strong></td>
<td>Commonly used to treat heart and kidney problems / promote urination, and therefore loss in weight / popular among wrestlers, gymnasts, and weightlifters / increased urination causes dilution of other drugs in the system</td>
<td>Dehydration / skin rashes / stomach problems / muscle cramps / blood disorders</td>
</tr>
<tr>
<td><strong>Narcotics</strong></td>
<td>Increased strength / alertness / endurance</td>
<td>Sleepiness / unconsciousness</td>
</tr>
<tr>
<td><strong>Stimulants</strong></td>
<td>Chemicals that excite the brain and stimulate the central nervous system / create euphoric effects and delay fatigue / can be inhaled, injected, or swallowed</td>
<td>Prolonged use can contribute to mental illness / malnutrition / blockage of blood vessels / dizziness</td>
</tr>
<tr>
<td>Type of Ergogenic Substance</td>
<td>Use and Effects</td>
<td>Health Risks</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Prohormones</td>
<td>Produced naturally by the pituitary gland / can increase muscle strength when injected in liquid form / hard to detect using urine and blood tests / now in synthetic form</td>
<td>Stunted growth / clogged arteries / blood pressure change / acne / nervous tension</td>
</tr>
<tr>
<td>Human growth hormone (HGH)</td>
<td>Produced by our bodies naturally, yet some athletes seek to raise its level in their bodies by injecting synthetic preparations / extra amounts are believed to increase muscle mass, strengthen bones, limit weight gain, and improve aerobic endurance / its effectiveness remains unproven</td>
<td>High use of HGH can lead to heart, kidney, and liver problems as well as skeletal abnormalities</td>
</tr>
<tr>
<td>Blood doping</td>
<td>Does not involve the use of drugs / intravenous infusion of extra red blood cells into the body / More blood cells produce more oxygen, thereby boosting endurance, stamina, and performance / used in long-distance running, cycling, and skiing</td>
<td>Allergic reactions / jaundice / poor circulation / blood clots / transmission of AIDS or hepatitis / metabolic shock</td>
</tr>
<tr>
<td>Pain-masking drugs</td>
<td>Include morphine, heroin, pethidine, and dextropropoxyphene / work by interfering with the body's ability to sense pain by blocking the nerve impulses that normally travel to the brain</td>
<td>Side effects include addiction and possible serious injury because the body's natural response to pain is blocked.</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>Used to treat heart attacks and blood pressure problems / help to control body movements / can enhance performance in sports such as archery and shooting</td>
<td>Heart failure / asthma / depression</td>
</tr>
<tr>
<td>Erythropoietin (EPO)</td>
<td>EPO is a natural protein hormone, produced by the kidneys, that stimulates production of red blood cells / synthetic EPO can increase hemoglobin levels, which increases oxygen-carrying capacity of red blood cells / some athletes such as long-distance cyclists use it to boost performance</td>
<td>Because EPO increases red blood cell count, it causes the heart to work harder, which in turn increases the risk of cardiac failure.</td>
</tr>
</tbody>
</table>
WORKSHEET

Chapter 16 Quiz

The two sets of questions below will test your knowledge and broaden your understanding of the material covered in Chapter 16. Complete each set of questions according to your teacher's instructions.

Question Set 1: Nutritional, Pharmacological, and Physiological Aids

Multiple-Choice Questions

**MISSION:** Circle the letter beside the answer that you believe to be correct.

1. Substances and techniques used by athletes to improve performance and recovery are known as
   - (a) ergogenic aids
   - (b) dietary aids
   - (c) physiological aids
   - (d) pharmacological aids
   ✔ (a) ergogenic aids

2. Which of the following substances have athletes used to promote fat loss?
   - (a) carnitine
   - (b) protein supplements
   - (c) creatine
   - (d) caffeine
   ✔ (a) carnitine

3. The international standard that identifies substances and methods that are banned in sport is known as
   - (a) the World Anti-Doping Agency List
   - (b) the IOC Banned List
   - (c) the Canada Vigilance Program List
   - (d) the Prohibited List
   ✔ (d) the Prohibited List

4. Competitors in endurance sports such as cycling may try to enhance their performance by taking
   - (a) anabolic steroids
   - (b) erythropoietin
   - (c) beta-blockers
   - (d) human growth hormone
   ✔ (d) human growth hormone

5. Which of the following ergogenic techniques does not involve ingesting a substance?
   - (a) drug masking
   - (b) creatine
   - (c) blood doping
   - (d) human growth hormone
   ✔ (c) blood doping

6. Which of the following ergogenic aids is used, illegally, by athletes to enhance aerobic athletic performance?
   - (a) blood doping
   - (b) creatine
   - (c) erythropoietin
   - (d) a and c
   ✔ (d) a and c

Short-Answer Questions

**MISSION:** Briefly answer the following questions in the space provided:

1. Which common stimulant, although legal, might cause problems for athletes, and why?
   Caffeine; intake can easily exceed the IOC's acceptable levels for doping; side effects include dizziness, insomnia, headache.

2. What are anabolic steroids and why do some athletes ingest them?
   Synthetic versions of testosterone; to increase muscle mass.

3. What are the side effects of ingesting extra human growth hormone (HGH)?
   Heart, kidney, and liver problems and skeletal abnormalities.

Essay Questions

**MISSION:** On a separate piece of paper, develop a 100-word response to the following questions.

1. Choose one ergogenic aid from each classification (nutritional, pharmacological, and physiological). Describe the benefits and/or risks associated with each of them.

2. Discuss drug-testing protocols in competitive sports. What are the consequences of testing positive for a banned substance at a major international event?

3. What is the stance of Health Canada and the Dietitians of Canada regarding consumption of sport foods and energy drinks?
Question Set 2: Technology, Equipment Design, and Digital Aids

Multiple-Choice Questions

MISSION: Circle the letter beside the answer that you believe to be correct.

1. Today, the most significant influence on technological aids to boost athletic performance is
   (a) material science and design  
   (b) aerospace engineering
   ✓ (c) digital advances  
   (d) nanotechnology

2. A subfield of physics called computational fluid dynamics is now indispensable to the design of
   (a) helicopters  
   (b) fishing rods  
   (c) basketball and training shoes
   ✓ (d) clothing for speed-based sports such as cycling, skating, and swimming

3. The world's top bobsled designers are now replicating the aerodynamics of
   (a) airplanes
   ✓ (b) Formula One race cars  
   (c) a classic teardrop, airfoil shape  
   (d) bodywork designed for straight-line speed

4. Protective gear made of new “reactive materials” that can flex and move with a body in motion but harden upon impact is the result of
   (a) inventions of new thermoset materials
   (b) innovations in low-friction fabric design
   ✓ (c) innovations in nanotechnology
   (d) wireless networks embedded in clothing

5. A major sport and fitness trend today is
   (a) smartphone integration with social media  
   (b) wireless activity trackers
   (c) virtual gyms
   ✓ (d) all of the above

6. A tool that can measure the intensity of physical activity is
   (a) a pedometer
   (b) a health-and-fitness wristband
   (c) an accelerometer
   ✓ (d) (a) and (c) are correct

Short-Answer Questions

MISSION: Briefly answer the following questions in the space provided:

1. Give four examples of wearable fitness technology.
   “Smart” clothing to monitor athletes' heart rate, body temperature, and hydration; battery-powered “hot pants” for cyclists; thermal regulation fabrics for golfers; fitness bands.

2. List five items of sports equipment that rely on carbon nanotubes for improved functioning.
   Baseball bats, golf clubs, bicycles, kayaks, archery equipment.

3. What are some popular tools for measurement and motivation related to physical activity and sport?
   Pedometer to record number of steps taken; accelerometer to record information about the frequency, duration, intensity, and patterns of the wearer’s movements; heart rate monitors to measure exercise intensity.

Essay Questions

MISSION: On a separate piece of paper, develop a 100-word response to the following questions.

1. Expand on this statement: “The design and adaptation of sports and leisure products to improve performance are benefiting from a boom in technological innovation.”

2. Explain, with examples, how technological innovation can lead to improved sport equipment design.

3. Discuss whether innovations in helmet design might or might not reduce the number of concussions experienced by sport participants.