<table>
<thead>
<tr>
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<tbody>
<tr>
<td>A</td>
<td>List of Experts</td>
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<tr>
<td>B</td>
<td>Multiple Intelligence Inventory – 145 Items with their Targeted Domains.</td>
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<td>C</td>
<td>Multiple Intelligence Inventory – Draft Form</td>
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<td>D</td>
<td>Multiple Intelligence Inventory – 145 Items with their Calculated ‘t’ Values</td>
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<td>E</td>
<td>Multiple Intelligence Inventory – Final Form</td>
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<td>Kolb’s Learning Style Inventory</td>
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<td>Lesson Plans Based on Multiple Intelligence Approach</td>
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<td>Achievement Test in Biology – Part I Draft Form</td>
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<tr>
<td>I</td>
<td>Achievement Test in Biology – Part II Draft Form</td>
</tr>
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<td>Scoring Key of the Achievement Test in Biology – Part I &amp; Part II (Draft Form)</td>
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<td>Difficulty Index and Discriminating Power of the Test Items in the Part I and Part II of the Draft form of the Achievement test</td>
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<td>Scoring Key of the Achievement Test in Biology – Final Form</td>
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</tbody>
</table>
LIST OF EXPERTS

Dr. K. R. Sivadasan  
Former Professor & Dean  
Faculty of Education  
University of Kerala

Dr. M. A. Sudheer  
Professor & Head  
Department of Applied Research  
Gandhigram Rural University  
Tamilnadu

Dr. K. Soman  
Professor & Head (Rtd)  
Faculty of Education  
Calicut University

Dr. Raseena Padmam.  
Professor & Director  
School of Behavioural Sciences  
M. G. University  
Kottayam

Dr. A. Sukumaran  
Reader  
School of Behavioural Sciences  
M. G. University  
Kottayam

Dr. P. Viswanadhan  
Professor & Head  
Department of Education  
University of Kerala

Rev. Fr. Antony Kanjirathanathu  
Teacher, Physical Education,  
St. Ephrem’s H. S. S.  
Mannanam

Dr. Theresa Susan  
Head of the Department  
Department of Education  
University of Kerala

Dr. B. Vijayakumar  
Director  
SSA Kerala

Dr. A. P. Wilson, M. D.  
St. John’s Hospital  
Kattappana

Rev. Fr. Thomas P.J. Pemala  
Lecturer,  
St. Joseph’s Training College,  
Mannanam

Dr. P. S. Manjit, M. S.  
Ophthalmology  
Senior Lecturer  
Kottayam

Dr. V. T. Mathew  
Former Principal  
St. Joseph’s Training College,  
Mannanam

Dr. Exemmal  
Prof & Head (Rtd)  
Dept. of Education  
University of Kerala
Dr. Usha P.          Dr. Claramma Jacob
Head of the Department Senior Grade Lecturer
Department of Education Dept. of Zoology
University of Calicut Alphonsa College, Pala.

Dr. Lilly Chacko       Dr. Kunjannamma John
Head of the Department Head of the Department
Department of Zoology Department of English
Alphonsa College, Pala  Alphonsa College, Pala
Appendix B

Multiple Intelligence Inventory

For Secondary School Students

(145 Items with their targeted domains)

Verbal/Linguistic Intelligence

Reading: skill in reading

1. I like to read books, magazines and newspapers.
2. I enjoy reading phrases and quotations.
3. I have very good reading speed.
4. I prefer to learn by reading.
5. I concentrate in my pronunciation on reading.

Listening: skill in listening

1. I understand more when I listening radio than watching television
2. I can readily absorb information from speeches.
3. I enjoy hearing lectures.
4. I learn fast when somebody else read for me.
5. I can follow high speed lectures at the same speed in which it is delivered.

Writing: ability and interest in writing of poems, stories, books and letters

1. I like to express my ideas in writing.
2. I grasp more when I take class notes.
3. I really like to participate in writing competitions.
4. I enjoy writing poems/ stories /essays.
5. I prefer to learn by writing.

Speaking: skill in oral communication

1. I enjoy tongue twisters/ nonsense rhymes/ puns.
2. I can effectively convey my ideas through conversation.
3. I can express my own views in verbal arguments.
4. I enjoy narrating stories.
5. I like to take part in debates /discussions.

Linguistic sensitivity: skill in the use of words for expressive and practical purposes

1. I like to learn new languages.
2. I often use fine vocabulary in my conversation.
3. My conversation includes frequent references to things that I've read or heard.
4. I enjoy searching new words.
5. I tend to note other people's errors in using words or grammar.

Logical/Mathematical Intelligence

Problem Solving: skill in organization, problem solving and logical reasoning; curiosity and investigation
1. I believe that there is a rational explanation for almost everything.
2. I take a step-by-step approach to solve problems given in classes.
3. Mathematics / science are my favourite subjects.
4. I enjoy logical puzzles.
5. I work best when I have a timetable.

Calculations: ability to work with numbers for mathematical operations such as addition and division
1. I enjoy working with numbers.
2. Budgeting money is easy for me.
3. I learn concepts faster when they are presented with numbers or bullets.
4. I can compute numbers in my mind within no time.
5. I enjoy games and brainteasers that involve mathematics.

Ability to perceive: logical patterns and relationships; statements and propositions; functions and complex processes and related abstractions
1. I like playing chess and cards.
2. I am good at figuring out patterns / logical sequences.
3. I quickly grasp cause effect relationships.
4. I can understand better when something is measured and categorized.
5. I can't begin an assignment until I have all my "ducks in a row".
6. I can easily trace out patterns presented in pictures.

Visual/ Spatial Intelligence

Imagery: use of mental imagery for observation, artistic, creative, and other visual activities
1. I am good at locating places in maps.
2. I prefer reading materials with lots of diagrammatic illustrations.
3. Knowing directions of different places is easy for me.
4. I can remember in detail the layout and landmarks of places I have visited.
5. I remember things best by seeing them.
6. I can easily read charts and graphs.
7. I can easily notice minute details in similar things.

**Artistic Design: to create artistic designs, drawings, painting or other crafts**

1. I used to rearrange my room frequently.
2. I like to spend time for jigsaw puzzles.
3. I like to produce new colours by mixing of different colours.
4. I enjoy decorating things.
5. I tend to create new designs during leisure time.

**Construction: to be able to make, build or assemble things**

1. I like to do art works.
2. Geometry is easier for me than algebra.
3. I can draw something that I have seen.
4. Viewing things in three dimensions is easy for me.
5. I am good at making moulds.
6. I enjoy doing craft works.

**Bodily/Kinesthetic Intelligence**

**Physical Skill: ability to move the whole body for physical activities such as balancing, coordination and sports**

1. I enjoy riding cycles.
2. I use gestures and body language when I talk.
3. I like to examine things by touching them.
4. I like to participate in athletic competition.
5. I am interested in doing regular physical exercises.

**Working with Hands: to use the hands with dexterity and skill for detailed activities and small work**

1. I have good eye-hand coordination
2. I like model building and carving.
3. I can easily repair things that are damaged.
4. I can do activities such as sewing / typing in good speed.
5. I prefer to be physically involved in activities rather than watching it.
6. I learn things by doing.

Musical/Rhythmical Intelligence

Musical ability: sensitivity to rhythms, pitch, tunes or melody; and the timbre or distinctive tone of a musical piece

1. If I hear a musical piece once or twice, I can easily repeat it.
2. I have a very good sense of pitch, tempo, and rhythm.
3. I like to give music to songs and poems.
4. I can sense when the music is out of pitch.
5. I memorize things by putting them in a rhyme

Instrument: skill and experience in playing a musical instrument

1. I like to play a musical instrument.
2. I can identify different musical instruments from their sounds.
3. I enjoy by making rhythmic sounds.
4. I used to make different musical instruments using raw materials.
5. I can play tunes in a musical instrument.

Vocal: a good voice for singing in tune and along with other people

1. I have a good singing voice.
2. I enjoy making music.
3. I often whistle or hum a tune.
4. I often sing melodies while working.
5. I am an active member of my school choir.

Appreciation: actively enjoys listening to music

1. I often have a tune running though my mind.
2. Listening to sounds in nature is very relaxing for me.
3. I prefer listening music than watching dramas.
4. I have wide and varied musical interests.
5. I really like music.
6. I like a musical background when I am working.
Interpersonal Intelligence

Understanding People: sensitivity to and understanding of other people's moods, feelings and point of view

1. I used to pacify others in their sorrows.
2. I can solve the quarrels among my friends.
3. I compliment others for their excellent performance.
4. I can quickly sense others.
5. I sympathize with other people's feelings

Getting along with others: able to maintain good relationships with other people especially friends and siblings

1. I dislike working alone.
2. I like to get involved in social activities.
3. I enjoy new or unique social situations.
4. I have no hesitation in talking to new people.
5. I enjoy sharing my ideas and feelings with others.
6. I can freely mingle with others.

Leadership: to take a leadership role among people through problem solving and influence

1. I like to take initiation in group activities.
5. I enjoy taking up leadership roles.
3. I like to recite pledge/news in school assembly.
4. I voluntarily take responsibilities.
5. I always be the leader of the group in which I belong

Intrapersonal Intelligence

Knowing Myself: awareness of one's own ideas, abilities; personal decision making skill

1. I often look for weaknesses in myself that I see in others
2. I really like to spend time by thinking about myself.
3. I work best when the activity is self-paced.
4. I am interested in participating personality tests and IQ tests.
5. I can tell easily whether someone likes me or not.
6. I have an idea of my own strengths and weaknesses.

**Goal Awareness:** awareness of goals and self correction and monitoring in light of a goal

1. I am ambitious about my future.
2. I used to wait eagerly for my examination results.
3. I think a lot about the future.
4. I understand that I am responsible for my own behaviour.
5. I have an important personal goal in my life.

**Managing Feelings:** ability to regulate one's feelings, moods and emotional responses

1. I spend time alone by way of meditation and reflection.
2. I am able to overcome the entire crisis in my life.
3. I can easily face a stressful situation.
4. I used to control myself in critical situations.
5. I can adjust to any situation easily.
6. I can predict how I will react to situations.

**Managing Behaviour:** ability to regulate one's mental activities and behavior

1. I believe that I am responsible for my actions.
2. I know how to behave in stressful situations.
3. I can tactfully deal with others.
4. I am a person with strong will power.
5. I do not waste my time on silly matters.

**Naturalistic Intelligence**

**Animal Care:** skill for understanding animal behavior, needs, characteristics

1. I support movements for the protection of animal rights.
2. I enjoy studying zoology.
3. I like to visit a zoo.
4. I have pet animals.
5. I like to feed birds.

**Plant Care:** ability to work with plants, (i.e., gardening, farming and horticulture)

1. I enjoy working in a garden
2. I can identify and name many different types of trees, flowers and plants.
3. I notice similarities and differences in trees, flowers and other things in nature.
4. I can’t tolerate cutting trees and plucking flowers.
5. I like to do new techniques such as budding / grafting.

**Love for Nature: Concern for Nature and activities to protect our Nature.**

1. I enjoy programmes that are connected to nature.
2. I am concerned about the depletion of the rain forest/ the ozone layer/ pollution.
3. I really love nature.
4. I have genuine interest in the global environmental issues.
5. I consider that conservation of natural resources is a major issue.
6. I have a good collection of different types of shells, rocks etc.
Appendix C

Multiple Intelligence Inventory

(Pilot study: Draft Multiple Intelligence Inventory for Secondary School Students)

Name of the student:

Standard: Division: Roll No:

Name of the school:

Instructions:

There are 145 behavioural statements in this inventory each with five choices such as Strongly Disagree, Disagree, Don't know, Agree and Strongly Agree. Read each statement carefully. Choose one of the five options for each statement indicating how well that statement describes you. Enter a tick mark (✓) in the column of your choice.

Strongly Disagree = Statement does not describe you at all
Disagree = Statement describes you very little
Don't know = Statement describes you somewhat
Agree = Statement describes you pretty well
Strongly Agree = Statement describes you exactly

Rate Yourself As You See Yourself, Not As You Think Others See You
<table>
<thead>
<tr>
<th>SI.NO</th>
<th>Multiple Intelligence Inventory</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Don't Know</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I like to read books, magazines and newspapers</td>
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<td>2</td>
<td>I understand more when listening radio than watching television</td>
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<td>3</td>
<td>I like to express my ideas in writing.</td>
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<td>4</td>
<td>I enjoy tongue twisters/ nonsense rhymes/puns.</td>
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<td>5</td>
<td>I like to learn new languages.</td>
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<td>6</td>
<td>I believe that there is a rational explanation for almost everything</td>
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<td>7</td>
<td>I enjoy working with numbers.</td>
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<td>8</td>
<td>I like playing chess and cards.</td>
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<td>9</td>
<td>I am good at locating places in maps.</td>
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<td>10</td>
<td>I used to rearrange my room frequently</td>
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<td>11</td>
<td>I like to do art works.</td>
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<td>12</td>
<td>I enjoy riding cycles.</td>
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<td>13</td>
<td>I have good eye-hand coordination</td>
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<td>14</td>
<td>If I hear a musical piece once or twice, I can easily repeat it.</td>
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<td>15</td>
<td>I like to play musical instruments</td>
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<td>16</td>
<td>I have a good singing voice.</td>
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<td>17</td>
<td>I often have a tune running through my mind</td>
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<td>18</td>
<td>I used to pacify others in their sorrows</td>
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<td>I dislike working alone.</td>
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<td>20</td>
<td>I like to take initiation in group activities.</td>
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<td>21</td>
<td>I often look for weaknesses in myself that I see in others</td>
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<tr>
<td>22</td>
<td>I am ambitious about my future</td>
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<td>23</td>
<td>I like to spend time by way of meditation and reflection</td>
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<tr>
<td>24</td>
<td>I believe that I am responsible for my actions.</td>
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<td>25</td>
<td>I support movements for the protection of animal rights.</td>
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<tr>
<td>26</td>
<td>I enjoy working in a garden</td>
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<td>SI.NO</td>
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<td>27</td>
<td>I enjoy programmes that are connected to nature.</td>
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<tr>
<td>28</td>
<td>I can easily trace out patterns presented in pictures.</td>
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<tr>
<td>29</td>
<td>I like a musical background when I am working.</td>
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<tr>
<td>30</td>
<td>I enjoy reading phrases and quotations.</td>
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<td>31</td>
<td>I can readily absorb information from speeches.</td>
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<td>32</td>
<td>I grasp more when I take class notes.</td>
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<td>33</td>
<td>I can effectively convey my ideas through conversation.</td>
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<td>34</td>
<td>I often use fine vocabulary in my conversation.</td>
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<td>35</td>
<td>I take a step-by-step approach to solve problems given in classes.</td>
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<td>36</td>
<td>Budgeting money is easy for me.</td>
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<td>37</td>
<td>I am good at figuring out patterns / logical sequences..</td>
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<td>38</td>
<td>I prefer reading materials with lots of diagrammatic illustrations.</td>
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<td>39</td>
<td>I like to spend time for jigsaw puzzles.</td>
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<td>40</td>
<td>Geometry is easier for me than algebra.</td>
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<td>41</td>
<td>I use gestures and body language when I talk.</td>
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<td>42</td>
<td>I like model building and carving.</td>
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<tr>
<td>43</td>
<td>I have a very good sense of pitch, tempo, and rhythm.</td>
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<td>44</td>
<td>I can identify different musical instruments from their sounds.</td>
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<td>45</td>
<td>I enjoy singing songs.</td>
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<td>46</td>
<td>Listening to sounds in nature is very relaxing for me.</td>
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<tr>
<td>47</td>
<td>I can solve the quarrels among my friends.</td>
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<tr>
<td>48</td>
<td>I like to get involved in social activities.</td>
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<tr>
<td>49</td>
<td>I enjoy taking up leadership roles.</td>
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<td>50</td>
<td>I really like to spend time by thinking about myself.</td>
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<tr>
<td>51</td>
<td>I used to eagerly wait for my examination.</td>
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<tr>
<td>SI.NO</td>
<td>Multiple Intelligence Inventory</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Don't Know</td>
<td>Agree</td>
<td>Strongly Agree</td>
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<tr>
<td>52</td>
<td>I am able to overcome the entire crisis in my life.</td>
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<tr>
<td>53</td>
<td>I know how to behave in stressful situations</td>
<td></td>
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<tr>
<td>54</td>
<td>I enjoy studying zoology</td>
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<tr>
<td>55</td>
<td>I can identify and name many different types of plants</td>
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</tr>
<tr>
<td>56</td>
<td>I am concerned about the depletion of the rain forest/ the ozone layer/ pollution</td>
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<tr>
<td>57</td>
<td>I can easily read charts and graphs</td>
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<tr>
<td>58</td>
<td>I can freely mingle with others</td>
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<tr>
<td>59</td>
<td>I have very good reading speed.</td>
<td></td>
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<tr>
<td>60</td>
<td>I enjoy hearing lectures</td>
<td></td>
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<tr>
<td>61</td>
<td>I really like to participate in writing competitions.</td>
<td></td>
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<tr>
<td>62</td>
<td>I can express my own views in verbal arguments</td>
<td></td>
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<tr>
<td>63</td>
<td>My conversation includes frequent references to things that I've read or heard.</td>
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<tr>
<td>64</td>
<td>Mathematics / science are my favourite subjects</td>
<td></td>
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<tr>
<td>65</td>
<td>I learn concepts faster when they are presented with numbers or bullets.</td>
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<tr>
<td>66</td>
<td>I quickly grasp cause effect relationships</td>
<td></td>
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<tr>
<td>67</td>
<td>Knowing directions of different places is easy for me.</td>
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<tr>
<td>68</td>
<td>I like to produce new colours by mixing of different colours.</td>
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<tr>
<td>69</td>
<td>I can draw something that I have seen.</td>
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<tr>
<td>70</td>
<td>I like to examine things by touching them</td>
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<tr>
<td>71</td>
<td>I can easily repair things that are damaged</td>
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<tr>
<td>72</td>
<td>I like to give music to songs and poems</td>
<td></td>
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<tr>
<td>73</td>
<td>I enjoy by making rhythmic sounds.</td>
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<tr>
<td>74</td>
<td>I often whistle or hum a tune.</td>
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<tr>
<td>75</td>
<td>I prefer listening music than watching dramas</td>
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<td>SI.NO</td>
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<tr>
<td>76</td>
<td>I compliment others for their excellent performance</td>
<td></td>
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<tr>
<td>77</td>
<td>I enjoy new or unique social situations</td>
<td></td>
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<tr>
<td>78</td>
<td>I like to recite pledge /news in school assembly</td>
<td></td>
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<tr>
<td>79</td>
<td>I work best when the activity is self-paced.</td>
<td></td>
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<tr>
<td>80</td>
<td>I think a lot about the future</td>
<td></td>
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<tr>
<td>81</td>
<td>I can easily face stressful situations</td>
<td></td>
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<tr>
<td>82</td>
<td>I can tactfully deal with others</td>
<td></td>
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<tr>
<td>83</td>
<td>I like to visit zoo.</td>
<td></td>
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<tr>
<td>84</td>
<td>I notice similarities and differences among things in nature.</td>
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<tr>
<td>85</td>
<td>I really love nature</td>
<td></td>
<td></td>
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<tr>
<td>86</td>
<td>I can easily notice minute details in similar things</td>
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<tr>
<td>87</td>
<td>I have an idea of my own strengths and weaknesses.</td>
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<tr>
<td>88</td>
<td>I prefer to learn by reading</td>
<td></td>
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<tr>
<td>89</td>
<td>I learn fast when somebody else read for me.</td>
<td></td>
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</tr>
<tr>
<td>90</td>
<td>I enjoy writing poems/ stories /essays</td>
<td></td>
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<tr>
<td>91</td>
<td>I enjoy narrating stories.</td>
<td></td>
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<tr>
<td>92</td>
<td>I enjoy searching new words.</td>
<td></td>
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<tr>
<td>93</td>
<td>I enjoy logic puzzles</td>
<td></td>
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<tr>
<td>94</td>
<td>I can compute numbers in my mind within no time.</td>
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<tr>
<td>95</td>
<td>I can understand better when something is measured and categorized.</td>
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<tr>
<td>96</td>
<td>I can remember in detail the layout and landmarks of places I've visited.</td>
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<tr>
<td>97</td>
<td>I enjoy decorating things.</td>
<td></td>
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<tr>
<td>98</td>
<td>Viewing things in three dimensions is easy for me.</td>
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<tr>
<td>99</td>
<td>I like to participate in athletic competition.</td>
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<tr>
<td>100</td>
<td>I can do activities such as sewing / typing in good speed.</td>
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<tr>
<td>101</td>
<td>I can sense when the music is out of pitch.</td>
<td></td>
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<tr>
<td>102</td>
<td>I used to make different musical instruments using raw materials.</td>
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<tr>
<td>103</td>
<td>I often sing melodies while working.</td>
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<tr>
<td>104</td>
<td>I have wide and varied musical interests</td>
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<tr>
<td>105</td>
<td>I can quickly sense others.</td>
<td></td>
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<tr>
<td>106</td>
<td>I have no hesitation in talking to strangers.</td>
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<tr>
<td>107</td>
<td>I voluntarily take responsibilities.</td>
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<tr>
<td>108</td>
<td>I am interested in participating personality tests and IQ tests</td>
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<tr>
<td>109</td>
<td>I understand that I am responsible for my own behaviour</td>
<td></td>
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<tr>
<td>110</td>
<td>I used to control myself in critical moments</td>
<td></td>
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<tr>
<td>111</td>
<td>I am a person with strong will power.</td>
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<tr>
<td>112</td>
<td>I have pet animals</td>
<td></td>
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<tr>
<td>113</td>
<td>I can’t tolerate cutting trees and plucking flowers.</td>
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<tr>
<td>114</td>
<td>I have genuine interest in the global environmental issues</td>
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<tr>
<td>115</td>
<td>I enjoy doing craft works</td>
<td></td>
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<tr>
<td>116</td>
<td>I can predict how I will react to situations.</td>
<td></td>
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<tr>
<td>117</td>
<td>I concentrate in my pronunciation while reading</td>
<td></td>
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<tr>
<td>118</td>
<td>I can follow high speed lectures at the same speed in which it is delivered.</td>
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<tr>
<td>119</td>
<td>I prefer to learn by writing.</td>
<td></td>
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<tr>
<td>120</td>
<td>I like to take part in debates /discussions</td>
<td></td>
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<tr>
<td>121</td>
<td>I tend to note other people's errors in using words or grammar</td>
<td></td>
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<tr>
<td>122</td>
<td>I work best when I have a timetable.</td>
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<tr>
<td>123</td>
<td>I enjoy games and brainteasers that involve mathematics</td>
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<tr>
<td>124</td>
<td>I can't begin an assignment until I have all my &quot;ducks in a row&quot;.</td>
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<tr>
<td>125</td>
<td>I remember things best by seeing them</td>
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<tr>
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<tr>
<td>126</td>
<td>I tend to create new designs during leisure time</td>
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<tr>
<td>127</td>
<td>I am good at making moulds.</td>
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<tr>
<td>128</td>
<td>I am interested in doing regular physical exercises.</td>
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</tr>
<tr>
<td>129</td>
<td>I prefer to be physically involved in activities rather than watching it.</td>
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<tr>
<td>130</td>
<td>I memorize things by putting them in a rhyme</td>
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<tr>
<td>131</td>
<td>I can play tunes in musical instruments</td>
<td></td>
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<tr>
<td>132</td>
<td>I am an active member of my school quire</td>
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<tr>
<td>133</td>
<td>I really like music.</td>
<td></td>
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<tr>
<td>134</td>
<td>I sympathize with other people's feelings</td>
<td></td>
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<tr>
<td>135</td>
<td>I enjoy sharing my ideas and feelings with others</td>
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<tr>
<td>136</td>
<td>I always be the leader of the group in which I belong</td>
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<tr>
<td>137</td>
<td>I can tell easily whether someone likes me or not</td>
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<tr>
<td>138</td>
<td>I have certain personal goals in my life.</td>
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<tr>
<td>139</td>
<td>I can adjust to any situation easily.</td>
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<tr>
<td>140</td>
<td>I do not waste my time on silly matters.</td>
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<tr>
<td>141</td>
<td>I like to feed birds.</td>
<td></td>
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<tr>
<td>142</td>
<td>I like to do new techniques such as budding / grafting.</td>
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<tr>
<td>143</td>
<td>I consider that conservation of natural resources is a major issue</td>
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<tr>
<td>144</td>
<td>I learn things by doing</td>
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<tr>
<td>145</td>
<td>I have a good collection of different types of shells, rocks etc</td>
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</tbody>
</table>
### Multiple Intelligence Inventory

**For Secondary School Students**

*(145 Items with Calculated ‘t’ values. The questions Selected for the Final Inventory are Denoted by **)*

#### Bodily/Kinaesthetic Intelligence

<table>
<thead>
<tr>
<th>No</th>
<th>Q No</th>
<th>Question</th>
<th>‘t’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q12**</td>
<td>I enjoy riding cycles.</td>
<td>3.058</td>
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<tr>
<td>2</td>
<td>q41**</td>
<td>I use gestures and body language when I talk.</td>
<td>2.779</td>
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<tr>
<td>3</td>
<td>q70**</td>
<td>I like to examine things by touching them.</td>
<td>2.959</td>
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<tr>
<td>4</td>
<td>q99**</td>
<td>I like to participate in athletic competition.</td>
<td>5.206</td>
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<tr>
<td>5</td>
<td>q128**</td>
<td>I am interested in doing regular physical exercises.</td>
<td>4.416</td>
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<tr>
<td>6</td>
<td>q13**</td>
<td>I have good eye-hand coordination.</td>
<td>2.578</td>
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<tr>
<td>7</td>
<td>q42**</td>
<td>I like model building and carving.</td>
<td>4.145</td>
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<tr>
<td>8</td>
<td>q71**</td>
<td>I can easily repair things that are damaged.</td>
<td>5.212</td>
</tr>
<tr>
<td>9</td>
<td>q100**</td>
<td>I can do activities such as sewing / typing in good speed.</td>
<td>5.908</td>
</tr>
<tr>
<td>10</td>
<td>q129</td>
<td>I prefer to be physically involved in activities rather than watching it.</td>
<td>1.956</td>
</tr>
<tr>
<td>11</td>
<td>q144**</td>
<td>I learn things by doing.</td>
<td>3.059</td>
</tr>
</tbody>
</table>

#### Verbal/Linguistic Intelligence

<table>
<thead>
<tr>
<th>No</th>
<th>Q No</th>
<th>Question</th>
<th>‘t’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q5</td>
<td>I like to learn new languages.</td>
<td>1.208</td>
</tr>
<tr>
<td>2</td>
<td>q34**</td>
<td>I often use fine vocabulary in my conversation.</td>
<td>4.711</td>
</tr>
<tr>
<td>3</td>
<td>q63</td>
<td>My conversation includes frequent references to things that I've read or heard.</td>
<td>3.141</td>
</tr>
<tr>
<td>4</td>
<td>q92**</td>
<td>I enjoy searching new words.</td>
<td>3.606</td>
</tr>
<tr>
<td>5</td>
<td>q121</td>
<td>I tend to note other people's errors in using words or grammar.</td>
<td>2.535</td>
</tr>
<tr>
<td>6</td>
<td>q2</td>
<td>I understand more when listening radio than watching television.</td>
<td>1.725</td>
</tr>
<tr>
<td>7</td>
<td>q31**</td>
<td>I can readily absorb information from speeches.</td>
<td>3.38</td>
</tr>
<tr>
<td>8</td>
<td>q60</td>
<td>I enjoy hearing lectures.</td>
<td>3.385</td>
</tr>
<tr>
<td>9</td>
<td>q89**</td>
<td>I learn fast when somebody else read for me.</td>
<td>4.13</td>
</tr>
<tr>
<td>10</td>
<td>q118</td>
<td>I can follow high speed lectures at the same speed in which it is delivered.</td>
<td>1.956</td>
</tr>
<tr>
<td>11</td>
<td>q1**</td>
<td>I like to read books, magazines and newspapers.</td>
<td>4.429</td>
</tr>
<tr>
<td>12</td>
<td>q30</td>
<td>I enjoy reading phrases and quotations.</td>
<td>1.429</td>
</tr>
<tr>
<td>No</td>
<td>Q No</td>
<td>Statement</td>
<td>t value</td>
</tr>
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<td>----</td>
<td>------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>13</td>
<td>q59**</td>
<td>I have very good reading speed.</td>
<td>3.721</td>
</tr>
<tr>
<td>14</td>
<td>q88</td>
<td>I prefer to learn by reading.</td>
<td>0.428</td>
</tr>
<tr>
<td>15</td>
<td>q117</td>
<td>I concentrate in my pronunciation on reading.</td>
<td>1.647</td>
</tr>
<tr>
<td>16</td>
<td>q4</td>
<td>I enjoy tongue twisters/ nonsense rhymes/ puns.</td>
<td>1.705</td>
</tr>
<tr>
<td>17</td>
<td>q33**</td>
<td>I can effectively convey my ideas through conversation.</td>
<td>2.792</td>
</tr>
<tr>
<td>18</td>
<td>q62</td>
<td>I can express my own views in verbal arguments.</td>
<td>3.083</td>
</tr>
<tr>
<td>19</td>
<td>q91**</td>
<td>I enjoy narrating stories.</td>
<td>3.44</td>
</tr>
<tr>
<td>20</td>
<td>q120</td>
<td>I like to take part in debates /discussions.</td>
<td>2.212</td>
</tr>
<tr>
<td>21</td>
<td>q3**</td>
<td>I like to express my ideas in writing.</td>
<td>3.561</td>
</tr>
<tr>
<td>22</td>
<td>q32</td>
<td>I grasp more when I take class notes.</td>
<td>3.364</td>
</tr>
<tr>
<td>23</td>
<td>q61</td>
<td>I really like to participate in writing competitions.</td>
<td>2.675</td>
</tr>
<tr>
<td>24</td>
<td>q90</td>
<td>I enjoy writing poems/ stories /essays.</td>
<td>1.844</td>
</tr>
<tr>
<td>25</td>
<td>q119**</td>
<td>I prefer to learn by writing.</td>
<td>3.286</td>
</tr>
</tbody>
</table>

**Logical /Mathematical Intelligence**

<table>
<thead>
<tr>
<th>No</th>
<th>Q No</th>
<th>Statement</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q8</td>
<td>I like playing chess and cards.</td>
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</tr>
<tr>
<td>2</td>
<td>q28**</td>
<td>I can easily trace out patterns presented in pictures.</td>
<td>3.812</td>
</tr>
<tr>
<td>3</td>
<td>q37</td>
<td>I am good at figuring out patterns / logical sequences.</td>
<td>3.737</td>
</tr>
<tr>
<td>4</td>
<td>q66**</td>
<td>I quickly grasp cause effect relationships.</td>
<td>5.263</td>
</tr>
<tr>
<td>5</td>
<td>q95</td>
<td>I can understand better when something is measured and categorized.</td>
<td>2.721</td>
</tr>
<tr>
<td>6</td>
<td>q124**</td>
<td>I can't begin an assignment until I have all my &quot;ducks in a row&quot;.</td>
<td>3.787</td>
</tr>
<tr>
<td>7</td>
<td>q7</td>
<td>I enjoy working with numbers.</td>
<td>3.853</td>
</tr>
<tr>
<td>8</td>
<td>q36**</td>
<td>Budgeting money is easy for me.</td>
<td>4.791</td>
</tr>
<tr>
<td>9</td>
<td>q65</td>
<td>I learn concepts faster when they are presented with numbers or bullets.</td>
<td>1.311</td>
</tr>
<tr>
<td>10</td>
<td>q94**</td>
<td>I can compute numbers in my mind within no time.</td>
<td>6.015</td>
</tr>
<tr>
<td>11</td>
<td>q123**</td>
<td>I enjoy games and brainteasers that involve mathematics.</td>
<td>4.399</td>
</tr>
<tr>
<td>12</td>
<td>q6**</td>
<td>I believe that there is a rational explanation for almost everything.</td>
<td>3.747</td>
</tr>
<tr>
<td>13</td>
<td>q35**</td>
<td>I take a step-by-step approach to solve problems given in classes.</td>
<td>2.724</td>
</tr>
<tr>
<td>14</td>
<td>q64**</td>
<td>Mathematics / science are my favourite subjects.</td>
<td>3.018</td>
</tr>
<tr>
<td>15</td>
<td>q93</td>
<td>I enjoy logic puzzles.</td>
<td>1.122</td>
</tr>
<tr>
<td>16</td>
<td>q122**</td>
<td>I work best when I have a timetable.</td>
<td>3.755</td>
</tr>
</tbody>
</table>

**Visual/Spatial Intelligence**

<table>
<thead>
<tr>
<th>No</th>
<th>Q No</th>
<th>Statement</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q10**</td>
<td>I used to rearrange my room frequently.</td>
<td>4.752</td>
</tr>
<tr>
<td>2</td>
<td>q39**</td>
<td>I like to spend time for jigsaw puzzles.</td>
<td>5.285</td>
</tr>
<tr>
<td>3</td>
<td>q68</td>
<td>I like to produce new colours by mixing of different</td>
<td>1.489</td>
</tr>
<tr>
<td>No</td>
<td>Q No</td>
<td>Statement</td>
<td>t value</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>4</td>
<td>q97**</td>
<td>I enjoy decorating things.</td>
<td>4.205</td>
</tr>
<tr>
<td>5</td>
<td>q126</td>
<td>I tend to create new designs during leisure time.</td>
<td>1.886</td>
</tr>
<tr>
<td>6</td>
<td>q11</td>
<td>I like to do art works.</td>
<td>2.672</td>
</tr>
<tr>
<td>7</td>
<td>q40**</td>
<td>Geometry is easier for me than algebra.</td>
<td>4.883</td>
</tr>
<tr>
<td>8</td>
<td>q69**</td>
<td>I can draw something that I have seen.</td>
<td>5.164</td>
</tr>
<tr>
<td>9</td>
<td>q98**</td>
<td>Viewing things in three dimensions is easy for me.</td>
<td>5.449</td>
</tr>
<tr>
<td>10</td>
<td>q115</td>
<td>I enjoy doing craft works.</td>
<td>4.621</td>
</tr>
<tr>
<td>11</td>
<td>q127</td>
<td>I am good at making moulds.</td>
<td>3.197</td>
</tr>
<tr>
<td>12</td>
<td>q9</td>
<td>I am good at locating places in maps.</td>
<td>1.887</td>
</tr>
<tr>
<td>13</td>
<td>q38</td>
<td>I prefer reading materials with lots of diagrammatic illustrations.</td>
<td>2.638</td>
</tr>
<tr>
<td>14</td>
<td>q57**</td>
<td>I can easily interpret charts and graphs.</td>
<td>2.633</td>
</tr>
<tr>
<td>15</td>
<td>q67**</td>
<td>Knowing directions of different places is easy for me.</td>
<td>4.92</td>
</tr>
<tr>
<td>16</td>
<td>q86**</td>
<td>I can easily notice minute details in similar things.</td>
<td>2.712</td>
</tr>
<tr>
<td>17</td>
<td>q96</td>
<td>I can remember in detail the layout and landmarks of places I've visited.</td>
<td>1.195</td>
</tr>
<tr>
<td>18</td>
<td>q125**</td>
<td>I remember things best by seeing them.</td>
<td>2.482</td>
</tr>
</tbody>
</table>

**Inter Personal Intelligence**

<table>
<thead>
<tr>
<th>No</th>
<th>Q No</th>
<th>Statement</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q19**</td>
<td>I dislike working alone.</td>
<td>3.384</td>
</tr>
<tr>
<td>2</td>
<td>q48</td>
<td>I like to get involved in social activities.</td>
<td>0.895</td>
</tr>
<tr>
<td>3</td>
<td>q58**</td>
<td>I can freely mingle with others.</td>
<td>3.403</td>
</tr>
<tr>
<td>4</td>
<td>q77</td>
<td>I enjoy new or unique social situations.</td>
<td>2.385</td>
</tr>
<tr>
<td>5</td>
<td>q106**</td>
<td>I have no hesitation in talking to new people.</td>
<td>3.772</td>
</tr>
<tr>
<td>6</td>
<td>q135**</td>
<td>I enjoy sharing my ideas and feelings with others.</td>
<td>4.487</td>
</tr>
<tr>
<td>7</td>
<td>q20**</td>
<td>I like to take initiation in group activities.</td>
<td>3.383</td>
</tr>
<tr>
<td>8</td>
<td>q49</td>
<td>I enjoy taking up leadership roles.</td>
<td>2.589</td>
</tr>
<tr>
<td>9</td>
<td>q78</td>
<td>I like to recite pledge /news in school assembly.</td>
<td>3.46</td>
</tr>
<tr>
<td>10</td>
<td>q107**</td>
<td>I voluntarily take responsibilities.</td>
<td>4.537</td>
</tr>
<tr>
<td>11</td>
<td>q136**</td>
<td>I always be the leader of the group in which I belong.</td>
<td>6.374</td>
</tr>
<tr>
<td>12</td>
<td>q18**</td>
<td>I used to pacify others in their sorrows.</td>
<td>2.983</td>
</tr>
<tr>
<td>13</td>
<td>q47</td>
<td>I can solve the quarrels among my friends.</td>
<td>1.676</td>
</tr>
<tr>
<td>14</td>
<td>q76**</td>
<td>I compliment others for their excellent performance.</td>
<td>4.21</td>
</tr>
<tr>
<td>15</td>
<td>q105**</td>
<td>I can quickly sense others.</td>
<td>3.044</td>
</tr>
<tr>
<td>16</td>
<td>q134</td>
<td>I sympathize with other people's feelings.</td>
<td>1.155</td>
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</table>

**Intra Personal Intelligence**

<table>
<thead>
<tr>
<th>No</th>
<th>Q No</th>
<th>Statement</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q22</td>
<td>I am ambitious about my future.</td>
<td>1.77</td>
</tr>
<tr>
<td>2</td>
<td>q51**</td>
<td>I used to eagerly wait for my examination results.</td>
<td>3.653</td>
</tr>
<tr>
<td>3</td>
<td>q80</td>
<td>I think a lot about the future.</td>
<td>2.708</td>
</tr>
<tr>
<td>No</td>
<td>Q No</td>
<td>Statement</td>
<td>t value</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>4</td>
<td>q109</td>
<td>I understand that I am responsible for my own behaviour.</td>
<td>1.911</td>
</tr>
<tr>
<td>5</td>
<td>q138**</td>
<td>I have an important personal goal in my life.</td>
<td>2.24</td>
</tr>
<tr>
<td>6</td>
<td>q21</td>
<td>I often look for weaknesses in myself that I see in others.</td>
<td>0.342</td>
</tr>
<tr>
<td>7</td>
<td>q50**</td>
<td>I really like to spend time by thinking about myself.</td>
<td>3.91</td>
</tr>
<tr>
<td>8</td>
<td>q79**</td>
<td>I work best when the activity is self-paced.</td>
<td>4.712</td>
</tr>
<tr>
<td>9</td>
<td>q87**</td>
<td>I have an idea of my own strengths and weaknesses.</td>
<td>4.067</td>
</tr>
<tr>
<td>10</td>
<td>q108**</td>
<td>I am interested in participating personality tests and IQ tests.</td>
<td>3.522</td>
</tr>
<tr>
<td>11</td>
<td>q137**</td>
<td>I can tell easily whether someone likes me or not.</td>
<td>2.965</td>
</tr>
<tr>
<td>12</td>
<td>q24</td>
<td>I believe that I am responsible for my actions.</td>
<td>3.58</td>
</tr>
<tr>
<td>13</td>
<td>q53</td>
<td>I know how to behave in stressful situations.</td>
<td>0.215</td>
</tr>
<tr>
<td>14</td>
<td>q82</td>
<td>I can tactfully deal with others.</td>
<td>2.127</td>
</tr>
<tr>
<td>15</td>
<td>q111**</td>
<td>I am a person with strong will power.</td>
<td>3.014</td>
</tr>
<tr>
<td>16</td>
<td>q140</td>
<td>I do not waste my time on silly matters.</td>
<td>2.133</td>
</tr>
<tr>
<td>17</td>
<td>q23</td>
<td>I like to spend time by way of meditation and reflection.</td>
<td>3.316</td>
</tr>
<tr>
<td>18</td>
<td>q52</td>
<td>I am able to overcome the entire crisis in my life.</td>
<td>3.232</td>
</tr>
<tr>
<td>19</td>
<td>q81</td>
<td>I can easily face stressful situations.</td>
<td>4.456</td>
</tr>
<tr>
<td>20</td>
<td>q110**</td>
<td>I used to control myself in critical situations.</td>
<td>5.038</td>
</tr>
<tr>
<td>21</td>
<td>q116</td>
<td>I can predict how I will react to situations.</td>
<td>1.962</td>
</tr>
<tr>
<td>22</td>
<td>q139**</td>
<td>I can adjust to any situation easily.</td>
<td>2.954</td>
</tr>
</tbody>
</table>

### Musical/Rhythmical Intelligence

<table>
<thead>
<tr>
<th>No</th>
<th>Q No</th>
<th>Statement</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q17</td>
<td>I often have a tune running through my mind.</td>
<td>1.955</td>
</tr>
<tr>
<td>2</td>
<td>q29**</td>
<td>I like a musical background when I am working.</td>
<td>3.407</td>
</tr>
<tr>
<td>3</td>
<td>q46</td>
<td>Listening to sounds in nature is very relaxing for me.</td>
<td>1.14</td>
</tr>
<tr>
<td>4</td>
<td>q75**</td>
<td>I prefer listening music than watching dramas.</td>
<td>4.196</td>
</tr>
<tr>
<td>5</td>
<td>q104</td>
<td>I have wide and varied musical interests.</td>
<td>4.202</td>
</tr>
<tr>
<td>6</td>
<td>q133</td>
<td>I really like music.</td>
<td>2.731</td>
</tr>
<tr>
<td>7</td>
<td>q15</td>
<td>I like to play musical instruments.</td>
<td>2.385</td>
</tr>
<tr>
<td>8</td>
<td>q44**</td>
<td>I can identify different musical instruments from their sounds.</td>
<td>3.591</td>
</tr>
<tr>
<td>9</td>
<td>q73**</td>
<td>I enjoy by making rhythmic sounds.</td>
<td>3.828</td>
</tr>
<tr>
<td>10</td>
<td>q102</td>
<td>I used to make different musical instruments using raw materials.</td>
<td>4.572</td>
</tr>
<tr>
<td>11</td>
<td>q131**</td>
<td>I can play tunes in a musical instrument.</td>
<td>5.334</td>
</tr>
<tr>
<td>12</td>
<td>q14</td>
<td>If I hear a musical piece once or twice, I can easily repeat it.</td>
<td>2.24</td>
</tr>
<tr>
<td>13</td>
<td>q43</td>
<td>I have a very good sense of pitch, tempo, and rhythm</td>
<td>5.989</td>
</tr>
<tr>
<td>14</td>
<td>q72**</td>
<td>I like to give music to songs and poems</td>
<td>5.171</td>
</tr>
<tr>
<td>15</td>
<td>q101**</td>
<td>I can sense when the music is out of pitch.</td>
<td>5.471</td>
</tr>
<tr>
<td>16</td>
<td>q130**</td>
<td>I memorize things by putting them in a rhyme.</td>
<td>3.56</td>
</tr>
<tr>
<td>17</td>
<td>q16</td>
<td>I have a good singing voice.</td>
<td>3.565</td>
</tr>
<tr>
<td>No</td>
<td>Q No</td>
<td>Description</td>
<td>t value</td>
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<td>----</td>
<td>------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>18</td>
<td>q45</td>
<td>I enjoy singing songs.</td>
<td>3.898</td>
</tr>
<tr>
<td>19</td>
<td>q74**</td>
<td>I often whistle or hum a tune.</td>
<td>4.153</td>
</tr>
<tr>
<td>20</td>
<td>q103**</td>
<td>I often sing melodies while working.</td>
<td>6.508</td>
</tr>
<tr>
<td>21</td>
<td>q132</td>
<td>I am an active member of my school choir.</td>
<td>3.254</td>
</tr>
</tbody>
</table>

**Naturalistic Intelligence**

<table>
<thead>
<tr>
<th>No</th>
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<th>Description</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>q27**</td>
<td>I enjoy programmes that are connected to nature.</td>
<td>3.944</td>
</tr>
<tr>
<td>2</td>
<td>q56**</td>
<td>I am concerned about the depletion of the rain forest/ the ozone layer/ pollution.</td>
<td>3.092</td>
</tr>
<tr>
<td>3</td>
<td>q85</td>
<td>I really love nature.</td>
<td>3.606</td>
</tr>
<tr>
<td>4</td>
<td>q114</td>
<td>I have genuine interest in the global environmental issues.</td>
<td>1.337</td>
</tr>
<tr>
<td>5</td>
<td>q143**</td>
<td>I consider that conservation of natural resources is a major issue.</td>
<td>3.89</td>
</tr>
<tr>
<td>6</td>
<td>q145**</td>
<td>I have a good collection of different types of shells, rocks etc.</td>
<td>3.388</td>
</tr>
<tr>
<td>7</td>
<td>q25**</td>
<td>I support movements for the protection of animal rights.</td>
<td>3.143</td>
</tr>
<tr>
<td>8</td>
<td>q54</td>
<td>I enjoy studying zoology.</td>
<td>2.312</td>
</tr>
<tr>
<td>9</td>
<td>q83**</td>
<td>I like to visit zoo.</td>
<td>3.624</td>
</tr>
<tr>
<td>10</td>
<td>q112**</td>
<td>I have pet animals.</td>
<td>4.858</td>
</tr>
<tr>
<td>11</td>
<td>q141</td>
<td>I like to feed birds.</td>
<td>2.661</td>
</tr>
<tr>
<td>12</td>
<td>q26**</td>
<td>I enjoy working in a garden</td>
<td>3.308</td>
</tr>
<tr>
<td>13</td>
<td>q55</td>
<td>I can identify and name many different types of plants.</td>
<td>3.936</td>
</tr>
<tr>
<td>14</td>
<td>q84</td>
<td>I notice similarities and differences among things in nature.</td>
<td>3.528</td>
</tr>
<tr>
<td>15</td>
<td>q113**</td>
<td>I can’t tolerate cutting trees and plucking flowers.</td>
<td>4.808</td>
</tr>
<tr>
<td>16</td>
<td>q142**</td>
<td>I like to do new techniques such as budding / grafting.</td>
<td>4.027</td>
</tr>
</tbody>
</table>
APPENDIX E

MULTIPLE INTELLIGENCE INVENTORY FOR SECONDARY SCHOOL STUDENTS
MULTIPLE INTELLIGENCE INVENTORY FOR SECONDARY SCHOOL STUDENTS

Prepared by
TESSY JOSEPH KALLARACKAL, M.Sc., M.Phil., M.Ed.

Guided by
Dr. Celine Pereira
Reader
School of Pedagogical Science

MAHATMA GANDHI UNIVERSITY
KOTTAYAM
Multiple Intelligence Inventory

*For Secondary School Students*

Name of the student:

Standard: Division: Roll No:

Name of the school:

Instructions:

There are 80 statements in this inventory each with five choices such as Strongly Disagree, Disagree, Don't know, Agree and Strongly Agree. Read each statement carefully. Choose one of the five options for each statement indicating how well that statement describes you. Enter a tick mark (✓) in the column of your choice.

**Strongly Disagree** = Statement does not describe you at all
**Disagree** = Statement describes you very little
**Don't know** = Statement describes you somewhat
**Agree** = Statement describes you pretty well
**Strongly Agree** = Statement describes you exactly

*Rate Yourself As You See Yourself, Not As You Think Others See You*
<table>
<thead>
<tr>
<th>SI No</th>
<th>Statements</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Don’t Know</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I enjoy riding cycles.</td>
<td></td>
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<tr>
<td>2</td>
<td>I often use fine vocabulary in my conversation.</td>
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<tr>
<td>3</td>
<td>I can easily trace out patterns presented in pictures.</td>
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<tr>
<td>4</td>
<td>I used to rearrange my room frequently.</td>
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<tr>
<td>5</td>
<td>I enjoy group works/ studies</td>
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<tr>
<td>6</td>
<td>I used to eagerly wait for my examination results.</td>
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<tr>
<td>7</td>
<td>I like a musical background when I am working.</td>
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<tr>
<td>8</td>
<td>I enjoy programmes that are connected to nature.</td>
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<tr>
<td>9</td>
<td>I use gestures and body language when I talk.</td>
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<tr>
<td>10</td>
<td>I enjoy searching new words.</td>
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<tr>
<td>11</td>
<td>I quickly grasp cause effect relationships.</td>
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<tr>
<td>12</td>
<td>I like to spend time for jigsaw puzzles.</td>
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<tr>
<td>13</td>
<td>I can freely mingle with others.</td>
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<tr>
<td>14</td>
<td>I have an important personal goal in my life.</td>
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<tr>
<td>15</td>
<td>I prefer listening music than watching dramas.</td>
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<tr>
<td>16</td>
<td>I am concerned about the depletion of the rain forest/ the ozone layer/ pollution.</td>
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<tr>
<td>17</td>
<td>I like to examine things by touching them.</td>
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<tr>
<td>18</td>
<td>I can readily absorb information from speeches.</td>
<td></td>
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<tr>
<td>19</td>
<td>I can't begin an assignment until I have all my &quot;ducks in a row&quot;.</td>
<td></td>
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</tr>
<tr>
<td>SI No</td>
<td>Statements</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Don’t Know</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>20</td>
<td>I enjoy decorating things.</td>
<td></td>
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<tr>
<td>21</td>
<td>I have no hesitation in talking to new people.</td>
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<tr>
<td>22</td>
<td>I really like to spend time by thinking about myself.</td>
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<tr>
<td>23</td>
<td>I can identify different musical instruments from their sounds.</td>
<td></td>
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<tr>
<td>24</td>
<td>I consider that conservation of natural resources is a major issue.</td>
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<tr>
<td>25</td>
<td>I like to participate in athletic competition.</td>
<td></td>
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<tr>
<td>26</td>
<td>I learn fast when somebody else read for me.</td>
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</tr>
<tr>
<td>27</td>
<td>Budgeting money is easy for me.</td>
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<tr>
<td>28</td>
<td>Geometry is easier for me than algebra.</td>
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<tr>
<td>29</td>
<td>I enjoy sharing my ideas and feelings with others.</td>
<td></td>
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<tr>
<td>30</td>
<td>I work best when the activity is self-paced.</td>
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<tr>
<td>31</td>
<td>I enjoy by making rhythmic sounds.</td>
<td></td>
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<tr>
<td>32</td>
<td>I have a good collection of different types of shells, rocks etc.</td>
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<tr>
<td>33</td>
<td>I am interested in doing regular physical exercises.</td>
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<tr>
<td>34</td>
<td>I like to read books, magazines and newspapers.</td>
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<tr>
<td>35</td>
<td>I can compute numbers in my mind within no time.</td>
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<tr>
<td>36</td>
<td>I can draw something that I have seen.</td>
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<tr>
<td>37</td>
<td>I like to take initiation in group activities.</td>
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<tr>
<td>SI No</td>
<td>Statements</td>
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</tr>
<tr>
<td>38</td>
<td>I have an idea of my own strengths and weaknesses.</td>
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</tr>
<tr>
<td>39</td>
<td>I can play tunes in a musical instrument.</td>
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<tr>
<td>40</td>
<td>I support movements for the protection of animal rights.</td>
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<tr>
<td>41</td>
<td>I have good eye-hand coordination.</td>
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<tr>
<td>42</td>
<td>I have very good reading speed.</td>
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<tr>
<td>43</td>
<td>I enjoy games and brainteasers that involve mathematics.</td>
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<tr>
<td>44</td>
<td>Viewing things in three dimensions is easy for me.</td>
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<tr>
<td>45</td>
<td>I voluntarily take responsibilities.</td>
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<tr>
<td>46</td>
<td>I am interested in participating personality tests and IQ tests.</td>
<td></td>
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<tr>
<td>47</td>
<td>I like to give music to songs and poems.</td>
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<tr>
<td>48</td>
<td>I like to visit zoo.</td>
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<tr>
<td>49</td>
<td>I like model building and carving.</td>
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<tr>
<td>50</td>
<td>I can effectively convey my ideas through conversation.</td>
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<tr>
<td>51</td>
<td>I believe that there is a rational explanation for almost everything.</td>
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<tr>
<td>52</td>
<td>I can easily interpret charts and graphs.</td>
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<tr>
<td>53</td>
<td>I always be the leader of the group in which I belong.</td>
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<tr>
<td>54</td>
<td>I can tell easily whether someone likes me or not.</td>
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</tr>
<tr>
<td>SI No</td>
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<tr>
<td>55</td>
<td>I can sense when the music is out of pitch.</td>
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<tr>
<td>56</td>
<td>I have pet animals.</td>
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<tr>
<td>57</td>
<td>I can easily repair things that are damaged.</td>
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<tr>
<td>58</td>
<td>I enjoy narrating stories.</td>
<td></td>
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<tr>
<td>59</td>
<td>I take a step-by-step approach to solve problems given in classes.</td>
<td></td>
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<tr>
<td>60</td>
<td>Knowing directions of different places is easy for me.</td>
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</tr>
<tr>
<td>61</td>
<td>I used to pacify others in their sorrows.</td>
<td></td>
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</tr>
<tr>
<td>62</td>
<td>I am a person with strong will power.</td>
<td></td>
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</tr>
<tr>
<td>63</td>
<td>I memorize things by putting them in a rhyme.</td>
<td></td>
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</tr>
<tr>
<td>64</td>
<td>I enjoy working in a garden.</td>
<td></td>
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</tr>
<tr>
<td>65</td>
<td>I can do activities such as sewing / typing in good speed.</td>
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<tr>
<td>66</td>
<td>I like to express my ideas in writing.</td>
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<tr>
<td>67</td>
<td>Mathematics / science are my favourite subjects.</td>
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<tr>
<td>68</td>
<td>I can easily notice minute details in similar things.</td>
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<tr>
<td>69</td>
<td>I compliment others for their excellent performance.</td>
<td></td>
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<tr>
<td>70</td>
<td>I used to control myself in critical situations.</td>
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<tr>
<td>71</td>
<td>I often whistle or hum a tune.</td>
<td></td>
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<tr>
<td>72</td>
<td>I can't tolerate cutting trees and plucking flowers.</td>
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</tr>
<tr>
<td>SI No</td>
<td>Statements</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Don't Know</td>
<td>Agree</td>
<td>Strongly Agree</td>
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<tr>
<td>73</td>
<td>I learn things by doing.</td>
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<tr>
<td>74</td>
<td>I prefer to learn by writing.</td>
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<tr>
<td>75</td>
<td>I work best when I have a timetable.</td>
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<tr>
<td>76</td>
<td>I remember things best by seeing them.</td>
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<tr>
<td>77</td>
<td>I can quickly sense others feelings.</td>
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<tr>
<td>78</td>
<td>I can adjust to any situation easily.</td>
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<tr>
<td>79</td>
<td>I often sing melodies while working.</td>
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<tr>
<td>80</td>
<td>I like to do new techniques such as budding / grafting.</td>
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</tbody>
</table>
### Appendix F

**KOLB’S LEARNING STYLE INVENTORY**

<table>
<thead>
<tr>
<th>Name of the student</th>
<th>Name of the school</th>
<th>Standard</th>
<th>Division</th>
<th>Roll No:</th>
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<tbody>
<tr>
<td></td>
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1= least like you
4= most like you

<table>
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<tr>
<th>When I learn</th>
<th>2</th>
<th>4</th>
<th>1</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td>I am happy</td>
<td></td>
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</tr>
<tr>
<td>I am careful</td>
<td></td>
<td></td>
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<tr>
<td>I am fast</td>
<td></td>
<td></td>
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<tr>
<td>I am logical</td>
<td></td>
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</table>

1 When I learn

<table>
<thead>
<tr>
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<th>2</th>
<th>4</th>
<th>1</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like to deal with my feelings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like to think about ideas</td>
<td></td>
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</tr>
<tr>
<td>I like to be doing things</td>
<td></td>
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<tr>
<td>I like to watch and listen</td>
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</table>

2 When I best when learn

<table>
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<tr>
<th>I learn best when</th>
<th>2</th>
<th>4</th>
<th>1</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I listen and watch carefully</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I rely on logical thinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I trust my hunches and feelings</td>
<td></td>
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<tr>
<td>I work hard to get things done</td>
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</tbody>
</table>

3 When I am learning

<table>
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<th>4</th>
<th>1</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I tend to reason things out</td>
<td></td>
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<tr>
<td>I am responsible about things</td>
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<tr>
<td>I am quiet and reserved</td>
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<tr>
<td>I have strong feelings and reactions</td>
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</table>

4 I learn by

<table>
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<th>1</th>
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<tr>
<td></td>
<td>When I learn</td>
<td></td>
<td>When I am learning</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------</td>
<td>---</td>
<td>--------------------</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>I am open to new experiences</td>
<td></td>
<td>I look at all sides of issues</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I am an observing person</td>
<td></td>
<td>I am an active person</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Observation</td>
<td></td>
<td>Personal relationship</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I like to see results from my work</td>
<td></td>
<td>I like ideas and theories</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I rely on my observations</td>
<td></td>
<td>I rely on my feelings</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I am a reserved person</td>
<td></td>
<td>I am an accepting person</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I get involved</td>
<td></td>
<td>I like to observe</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I analyze ideas</td>
<td></td>
<td>I am receptive and open-minded</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX G

Lesson Plans Based on

MULTIPLE INTELLIGENCE APPROACH
LESSON PLANS BASED ON
MULTIPLE INTELLIGENCE APPROACH

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Reader
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KOTTAYAM
Lesson Plan No: 1

Lesson Title: Sense Organs

Lesson Objectives:

The pupil:

1. Analysing the common characteristics of the sense organs.
2. Comparing the direction of signals from the receptor organs.
3. Creating flow chart of the impulse transmission from the sensory organs to the CNS.
5. Evaluating the complexity of the sense organs in accordance with evolution.
6. Analysing the transduction.
7. Developing positive attitude towards eye donation
8. Identifying the protective measures of our eyes.
9. Identifying different layers of the eye ball.
10. Analysing the electromagnetic spectrum.

Intelligences Focused in Various Activities

- Verbal/linguistic learners: activities - all activities
- Mathematical/logical learners: activities – 1,3,4,9,10,11,12,13,14,15,16.
- Visual/spatial learners: activities - all activities
- Bodily/kinaesthetic learners: activities -3,5,6,9,17
- Musical/rhythmic learners: activities -2,5,6.
- Interpersonal learners: activities -1,3,4,5,6,7,10,15,16,17
- Intrapersonal learners: activities -1,2,3,8,10,11,14,17
- Naturalist learners: activities - 2,3,4,7,8,9,10,11,13,14,15,16
### Learning activities

**Activity :1 (Group)**

Students are divided into groups, with four to five students in each group. Observe the diagram given below, discuss and find out:

<table>
<thead>
<tr>
<th>Focused Intelligences:</th>
<th>Visual/Spatial and Mathematical-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligences</td>
<td>Logical Intelligences</td>
</tr>
<tr>
<td>Additional Intelligences:</td>
<td>Interpersonal, and Intrapersonal Intelligences</td>
</tr>
</tbody>
</table>

1. The common characteristics of the above five organs.
2. Name the receptor organs in the human body.
3. Compare the direction of signals from receptor organs.
4. Bring out the importance of the central nervous system in the transmission of signals.

**Teacher consolidates** by using the animation of impulse
transmission through the neurones to the central nervous system (CNS).

**Sensory Receptors**

- Are specially modified nerve endings that convert stimuli from the environment into nerve impulses that are transmitted to the central nervous system.

- They can detect changes in the environment and are used by animals to obtain information about the environment.

- Receptors are specific for the type of stimulus that they can detect. For example, photoreceptors can only detect light.

- Receptors function by depolarizing neurons and producing action potentials. When a receptor is stimulated, it sends a signal along the nerve cells to the CNS. Usually, the brain - which is part of the nervous system - coordinates a response
Teacher explains: Sensory Organs

- Sensory receptors may be arranged into sensory organs.
- Sensory organs are better able to detect stimuli.
- For example, photoreceptors on the surface of an animal can detect the presence of light but the photoreceptors in the eye (an organ) can be used to form an image.

Activity: 2 (Individual)

Observe the given table and find out the sense organs that can receive the particular stimuli.

<table>
<thead>
<tr>
<th>Sense organ</th>
<th>Receptors sensitive to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pressure, pain, temperature</td>
</tr>
<tr>
<td></td>
<td>chemicals in food</td>
</tr>
<tr>
<td></td>
<td>chemicals in the air</td>
</tr>
<tr>
<td></td>
<td>light</td>
</tr>
<tr>
<td></td>
<td>sound, the position of the head</td>
</tr>
</tbody>
</table>

Teacher consolidates by using the animation of electrical signal transmission to the CNS with musical background particular to each type of sense organs.

Sensory receptors are transducers

- Sensory receptors convert stimuli into electric signals that are specialized to respond to only certain stimuli, which will activate the receptor.
- The signal is then chemically amplified within the
receptor cells.

- This produces an electrical signal that will be transmitted to the central nervous system

Types of receptors

**Chemoreceptors**

- **Gestation**
  - Respond to dissolved molecules that come in contact with the receptors

- **Olfaction (smell)**
  - Respond to airborne molecules from sources a distance away.

**Mechanoreceptors**

- Are sensing physical contact on the surface of the skin or movement of the surrounding environment
- The simplest mechanoreceptors are nerve endings of skin’s connective tissue.
- The most complex example occurs in the middle and inner ear of vertebrates. The hair cell is the basic unit of vertebrate mechanoreception.

**Photoreceptors**

- Is the translation of photons of light into electrical and then neuronal signals.
**Activity:3 (Group)**

Study the flow chart of the impulse transmission from the sensory organs to the CNS and construct a separate pathway for each sense organ by using symbols of your choice in the groups.

**Teacher Consolidates** the different pathways by using power point slides

**Sensory Reception and Brain**

**Teacher explains:**

- All sensory signals go first to a relay station in the thalamus, a central structure in the brain.
- The messages then travel to primary sensory areas in the cortex (a different area for each sense).
- There they are modified and sent on to "higher" regions of the brain. Somewhere along the way, the brain figures out what the messages mean.
Activity: 4 (Group)

Some animals have developed amazing adaptations to their environments. Many different types of energy exist in the environment, some of which humans cannot detect. Here are some examples of how some animals sense the outside world and the anatomical structures that allow them to do so. Carefully study these Amazing Animal Senses and try to answer the following questions.

1. Where do the taste receptors located? 1. on a butterfly 2. on an earthworm 3. on an octopus

2. How many lenses does a fly's eye have?

3. How could a rattlesnake find its prey in the dark?

4. What senses do bats use to find food?

5. “The number and complexity of receptors increase as we go from the lower organisms to the higher organisms”. Find out examples from each levels of classification to substantiate the above statement.

6. Which are the highly developed senses of man who stands in the highest level?

7. Find out the most common types of receptor

Focused Intelligences:
Naturalistic and Interpersonal Intelligences

Additional Intelligences:
Visual/Spatial and Logical/mathematical Intelligences
organs that animals use to detect and respond to changes in their environment.

8. Discuss the diversity of these receptors according to the mode of life of each organism.

<table>
<thead>
<tr>
<th>Earthworm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire body covered with chemoreceptors (taste receptors).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can see light between wavelengths 300 and 650 nm.</td>
</tr>
<tr>
<td>Worker honey bees have 5,500 lenses (&quot;ommatidia&quot;) in each eye.</td>
</tr>
<tr>
<td>Have chemoreceptors (taste receptors) on their jaws, forelimbs and antennae.</td>
</tr>
<tr>
<td>Worker honey bees have a ring of iron oxide (&quot;magnetite&quot;) in their abdomens that may be used to detect magnetic fields. They may use this ability to detect changes in the earth's magnetic field and use it for navigation.</td>
</tr>
<tr>
<td>Can see polarized light.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Butterfly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has chemoreceptors (taste receptors) on its feet.</td>
</tr>
<tr>
<td>The butterfly has hairs on its wings to detect changes in air pressure.</td>
</tr>
</tbody>
</table>
• Using vision, the butterfly Colias can distinguish two points separated by as little as 30 microns. (Humans can distinguish two points separated by 100 microns.)

**Mosquito**

Attracted to host by human body odour (especially foot odour), carbon dioxide, body heat and body humidity

**Fly**

• Each eye has 3,000 lenses. Eye has a flicker fusion rate of 300/sec. Humans have a flicker fusion rate of only 60/sec in bright light and 24/sec in dim light. The flicker fusion rate is the frequency with which the "flicker" of an image cannot be distinguished as an individual event. Like the frame of a movie...if you slowed it down, you would see individual frames. Speed it up and you see a constantly moving image.
• Blowflies taste with 3,000 sensory hairs on their feet

**Octopus**

• Retina contains 20 million photoreceptors.
- The eye has a flicker fusion frequency of 70/sec in bright light.
- The pupil of the eye is rectangular.
- Has chemoreceptors (taste receptors) on the suckers of their tentacles. By tasting this way, an octopus does not have to leave the safety of its home.

**Starfish**

- Arms covered with light sensitive cells. Light that projects on an "eyespot" on each arm causes the arm to move.

**Shark**

- Has specialized electro sensing receptors with thresholds as low as 0.005 uV/cm. These receptors may be used to locate prey. Some sharks sense light directly through the skull by the pineal body.
- The ampullae of Lorenzini are small vesicles that form part of an extensive subcutaneous sensory network system. These vesicles are found around the head of the shark. They detect weak magnetic fields produced by other fish at short ranges.
Snakes

- Pit-vipers have a heat-sensitive organ between the eyes and the nostrils about 0.5 cm deep. This organ has a membrane containing 7,000 nerve endings that respond to temperature changes as small as 0.002-0.003 degrees centigrade. A rattlesnake can detect a mouse 40 cm away if the mouse is 10 degrees centigrade above the outside temperature.

- The tongue of snakes has no taste buds. Instead, the tongue is used to bring smells and tastes into the mouth. Smells and tastes are then detected in two pits, called "Jacobson's organs", on the roof of their mouths. Receptors in the pits then transmit smell and taste information to the brain.

- Snakes have no external ears. Therefore, they do not hear the music of a "snake charmer". Instead, they are probably responding to the movements of the snake charmer and the flute. However, sound waves may travel through bones in their heads to the middle ear.

- Snakes have no moveable eyelids. Instead, they have a clear, scale-like membrane covering the eye.
Falcon

- Can see a 10 cm. object from a distance of 1.5 km.
- Visual acuity is 2.6 times better than human.
- Can see sharp images even when diving at 100 miles/hr.

Bats

- Can detect warmth of an animal from about 16 cm away using its "nose-leaf".
- Bats can also find food (insects) up to 18 ft. away and get information about the type of insect using their sense of echolocation.
- Can hear frequencies between 3,000 and 120,000 Hz.

Dog

- Has olfactory membrane up to 150 sq. cm.
- Can hear sound as high as 40,000 Hz.

Elephant

Has hearing range between 1 and 20,000 Hz. The very low frequency sounds are in the "infrasound" range. Humans cannot hear sounds in the infrasound range.
**Teacher Consolidates** by using the picture of the evolutionary tree and different sense organs of animals in the OHP sheet.

- The receptors help the organism to respond to stimuli.
- The number and complexity of receptors increase as we go from the lower organisms to the higher organisms. In the unicellular organism, chlamydomonas, light receptors help to recognize light. In the earthworm this spreads in the body wall and help to sense light. In the complex structured snake and mabuya receptors on their tongue help to recognize smell.
- These receptors which perform specific functions together form sense organs. Despite the diversity of these receptors, most function at the cellular level in very similar ways.

**Activity :5 (Group)**

Read the following points and dramatize this in your group with music.

1. Absorption of stimulus energy by the sensory cells.
2. Energy transduction, the conversion of the stimulus energy into chemo-electrical energy.
3. Production of a receptor potential
4. Conversion of receptor potential into an action potential of the afferent nerve.

**Focused Intelligences:**

Musical/Rhythmical and Bodily/Kinaesthetic Intelligences
5. Transmission of the afferent action potential to the central nervous system, specifically areas of the CNS that evaluate the frequency and intensity of the sensory signals.

6. The final response of the CNS to the sensory information, which may include a conscious or unconscious response, no response, or adaptation to repeated stimuli.

**Teacher explains: Human senses**

Our senses give us a wealth of information about the world. We can distinguish millions of colours, detect nearly 10,000 different odours, and perceive a vast range of sounds. To accomplish such feats, we rely on a complex partnership between the sense organs, which collect sensory information, and the brain, which processes it.

**Activity:6**

Read the following points and find out the energy transformations in each of the five sense organs and communicate these changes by composing a song with suitable rhythm. Eyes, Ears, Nose, Tongue and Skin

Humans have five basic senses: sight, hearing, smell, taste, and touch. The main sense organs—the eyes, ears, nose, tongue, and skin—contain receptors, special cells that detect changes in the environment.

**Additional Intelligences:**
- Interpersonal and Verbal/Linguistic Intelligences

**Focused Intelligences:**
- Musical/Rhythmical
- Visual/Spatial and Bodily/Kinaesthetic Intelligences
• One end of a receptor cell responds to a stimulus, such as light rays, molecules of certain chemicals, sound waves, temperature, or pressure.
• The receptor cell then converts the stimulus into an electrical signal, which is carried by nerves to the appropriate area of the brain.
• Like a computer, the brain then interprets these signals as images, tastes, smells, sounds, heat, cold, pressure, or pain. Different parts of the brain interpret information from the different senses.

Activity :7
Read this advertisement

1. Find out the message that this advertisement intends to convey you.
2. Find out the most striking words of this advertisement.
3. What is the major function of eyes?
4. Discuss the ways in which we use our sense of sight every day

Donate Your Eyes - Give sight to a Blind

Open others eye before close yours!
The eyes you donate give sight to two blind persons!
If you don’t donate your eyes at the time of death, you are literally letting them ‘die’ with you. So you are killing your eyes as you don’t let them live on.”

Eyes are too precious.

Don’t Burry or Burn

Don’t kill your eyes. Donate them instead.

Take An Initiative To Bring Colours To A Blind’s Life!

Your Eyes Can Add Light to Someone’s Life.

Pledge and Donate Eye

Teacher Consolidates

Look around. What do you see? Human beings can
obtain a large amount of information about the surrounding environment through their sense of vision. But to see, we need light and the light-processing organs called eyeballs. Sight is often thought of as the most important sense because we use our eyes constantly to learn more about the world around us. Eye is the sense organ which helps us most to gain knowledge.

**Activity 8**

Compare these diagrams and find out:

1. The exact location of our eyes.
2. The shape of our eyes.
3. Is it possible to see the entire eye while looking into the face of others

**Focused Intelligences:**

Visual/Spatial and Intrapersonal, Intelligences

**Additional Intelligences:**

Naturalistic and Verbal/Linguistic Intelligences
**Teacher consolidates** by using the pictures

- Eyes are situated in the eye sockets of the skull
- Human eye is about 2.5 cm in length and weighs about 7 grams

**Activity: 9**

Observe the demonstrations and try to find out: Without moving your head, look up. Look down. Look all around.

1. Whether the eye ball is firmly fixed or loosely attached to the eye orbit.
2. How is it attached?
3. Can you feel the movements of eye muscles with the movement of the eyes? How does movement of the eyes help you to read?
4. How the eye does get nourishments?

**Focused Intelligences:**

*Visual/Spatial and Bodily/Kinaesthetic Intelligences*

**Additional Intelligences:**

*Naturalistic and Logical / Mathematical Intelligences*
Eyes are attached to the eye sockets by means of six eye muscles.

Attached to the sclera are the muscles that move the eye, called the extraocular muscles.

Six muscles attached to the eyeball move each eye so we can look in different directions. Cows have only four muscles that control their eyes. They can look up, down, left, and right, but they can’t roll their eyes like we can.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Primary Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial rectus</td>
<td>moves eye towards nose</td>
</tr>
<tr>
<td>Lateral rectus</td>
<td>moves eye away from nose</td>
</tr>
<tr>
<td>Superior rectus</td>
<td>raises eye</td>
</tr>
<tr>
<td>Inferior rectus</td>
<td>lowers eye</td>
</tr>
<tr>
<td>Superior oblique</td>
<td>rotates eye</td>
</tr>
<tr>
<td>Inferior oblique</td>
<td>rotates eye</td>
</tr>
</tbody>
</table>
Nerves and blood vessels are entering into the eye through the opening in the eye socket.

**Activity: 10**

Students work as partners, look closely at the eye of your partner. Do this carefully. Draw the diagram of an eye, label the parts and write down all observations.

Answer these questions

1. Can you label these parts of the eye?
   - iris • pupil • eyelid • tear duct
2. Does your eye stay still?
3. Are all irises the same colour? What colour(s)?
4. Is your eye wet or dry?
5. How many times do they blink in a minute?
6. Does the iris open and close?

**Focused Intelligences:**
- Visual/Spatial,
- Mathematical/Logical and
- Bodily/Kinaesthetic

**Additional Intelligences:**
- Naturalistic,
- Interpersonal and
- Verbal/Linguistic
7. What does your eyelid keep doing? Why does it?
Follow up with an eye conference to compare results.

Teacher Consolidates

Activity: 11
Observe the diagram carefully and write a note on the protective measures of the eye

Eye Socket: Is a cone-shaped bony cavity that protects the eye. The socket is padded with fatty tissue that allows the eye to move easily.

Eyelashes and Eyebrows: These specialized hairs protect the eyes from particles that may injure them. They form a screen to keep dust and insects out.

Focused Intelligences:
Visual/Spatial and Mathematical/Logical Intelligences

Additional Intelligences:
Naturalistic, Intrapersonal and Verbal/Linguistic Intelligences
**Eyelids:** Our eyelids protect and lubricate our eyes. Small oil-producing glands line the inner edge of our eyelids. These oils mix with tears when we blink, keeping the eye moist and clean.

**Lacrimal Gland (Tear Duct):** This gland continually releases tears and other protective fluids onto the surface of the eye. It lubricates and keeps the eye from becoming dehydrated. Tears, which constantly bathe the surface of the eye, also remove dust and dirt – as well as killing bacteria.

**Conjunctiva:** The conjunctiva is a thin, clear membrane covering the front of the eye and inner eyelids. Inflammation of this membrane is called conjunctivitis, or pink eye.

**Activity: 12**

Observe the cross section of the two balls, one solid and the other hollow, and find out the differences in terms of:

1. Space inside.
2. Distinct membrane as a limiting wall.

**Focused Intelligences:**

*Visual/Spatial and Mathematical/Logical Intelligences*
Activity: 13
Find out the number of layers in:
1. The wall of the ball.
2. The cross section of a coconut.
3. Draw the cross section of a hollow ball having a three layered wall.

Teacher Consolidates

Three layered wall of the ball with a hollow space inside. Like this our eye ball also has a three layered wall.

Activity: 14
Carefully read the following descriptions and label the three layers of the eye ball. Label the three layers.

1. Sclera
   White, tough and outermost wall of the eye. It along with internal fluids keeps the shape and protects its delicate internal parts.

2. Choroid
   The choroid is the middle layer of blood vessels which supplies blood to the retina. Melanin is the pigment which gives dark colouration which absorbs the excess
light which enters into the eye. Numerous capillaries present in the choroid bring oxygen and nutrients required for the eye.

3. Retina

The retina is the film of the eye. It contains the light receptors, the rods and cones. It converts light rays into electrical signals and sends them to the brain through the optic nerve.

Teacher Consolidates: The Human Eye

Activity:15

Compare the air filled ball with that of an empty ball having no shape. Read the following hints and try to find out:

Vitreous Humor

Is a jelly like liquid that fills most of the eye. This preserves the spherical shape of our eyeball, as well as helping to support the retina. Despite having the consistency of egg white it is mainly made of water (99%).

1. What gives shape to the 1st ball?

Focused Intelligences: Visual/Spatial and Mathematical/Logic al Intelligences

Additional Intelligences: Naturalistic and Intrapersonal Intelligences
2. The function and nature of vitreous humor.

3. Where does it occur?

**Teacher Consolidates:** The Human Eye

![Diagram of the human eye with labeled vitreous humor]

**Activity: 16**
Discuss in your group and find out the necessary physical conditions for a clear vision.

**Teacher Consolidates**

The human eye is composed of many parts that work together. They receive visual images, focus them properly, and send messages to the brain.

To have vision, there must be three things:

(1) Eyes,

(2) Brain, and

(3) Light.

**Focused Intelligences:**
*Visual/Spatial and Mathematical/Logical Intelligences*

**Additional Intelligences:**
*Naturalistic and Interpersonal Intelligences*
Light rays bounce off an object we are looking at. Let’s say the object is a cat. The light reflects off the cat’s image and comes back to the eye.

**Activity: 17**

Observe the electromagnetic spectrum and find out:

1. Locate the range of the electromagnetic spectrum where humans detect light.

2. Discuss the various forms of electromagnetic energy and explain the meaning of the exponents ($10^4 = 10 \times 10 \times 10 \times 10$). Emphasize that the only difference between visible light and X-rays, for instance, is the wave length.

**Focused Intelligences:**
- Mathematical/Logic
- Visual/Spatial,
- and
- Bodily/Kinaesthetic

**Intelligences**
3. Locate the tiny band of light visible to human eyes, and then colour in the spectrum as indicated. (From left to right, red, yellow, green, blue, violet). Explain that colour is determined by the wavelength of light. Red, for instance, has a longer wavelength than violet.

4. Colour the rest of the electromagnetic spectrum black, indicating that it is invisible to human eyes. Therefore our eyes are sensitive to only a tiny band, although we can feel infrared as heat and ultraviolet produces sunburn.

5. Although human eyes are quite limited is that true of animals also?

6. Describe what it would be like to go clothes shopping if you could see NO colours, only shades of black, grey and white.

**Teacher Consolidates**

Waves in the electromagnetic spectrum vary in size from very long radio waves the size of buildings, to very short gamma-rays smaller than the size of the nucleus of an atom.

- **Radio** $10^8$ $10^7$
- **Microwave** $10^9$
- **Infrared** $10^4$
- **Visible** $10^7$
- **Ultraviolet** $10^4$
- **X-ray** $10^{-9}$
- **Gamma Ray** $10^{-10}$

Wavelength in centimeters

About the size of...
The Electromagnetic Spectrum and Vision

- The sun, which is the source of most of our visible light, also gives off radio waves, infra red, ultraviolet and X-rays.
- All these forms of energy travel as waves at 186,000 miles/second.
- The only difference between them is their wavelengths radio waves are very long and X-rays are extremely short with visible light somewhere in between.
- Actually bees can see ultraviolet as a visible colour. A flower that reflects ultraviolet will look quite different to a bee than a human, but on the other hand bees can’t see red—it probably looks black to them. A bee’s visual world is very different from a human’s visual world.
- Most mammals and all nocturnal animals see very little colour at all. We humans (along with bees and birds) are exceptions in having colour vision.
Lesson Plan No: 2

Lesson Title: Eye: Structure

Lesson Objectives:

The pupil:

1. Analysing the front part modifications of the three layers of the eye for light penetration.
2. Applying knowledge in finding out reasons for the difference in the colour of iris of people around the world.
3. Differentiating between the working of circular muscles and radial muscles according to the changes in the intensity of light.
4. Analysing the changes happened to the light rays which are entering into the eyes.
5. Analysing refraction and dispersion.
7. Analysing the media through which the light passes to get focused in the retina.
8. Experimenting and finds out the size and nature of the image by using convex lens.
9. Creating the process of vision.
10. Understanding the location of lens in the eye.
11. Analysing the change in curvature of the lens, ciliary muscles and suspensory ligaments with the focusing of near and distant objects.
12. Applying knowledge in finding out reasons for the accommodation power of the lens.
13. Creating a flow chart showing the pathway of light in the eye.
14. Comparing the external structure and arrangement of rods and cones in the retina.
15. Identifying the different regions in the retinal layer in relation with presence and absence of rods and cones.

16. Differentiating between Fovea and Blind Spot.

17. Applying knowledge in finding out reasons for the occurrence of night blindness when severe vitamin A deficiency is present.

18. Labelling different parts of the eye.

19. Designing experiment that tests how wide a person's field of vision is.

Intelligences Focused in Various Activities

- Verbal/linguistic learners: activities - all activities
- Mathematical/logical learners: activities - all activities
- Visual/spatial learners: activities - all activities
- Bodily/kinaesthetic learners: activities - 3, 5, 6, 8, 10, 13, 14, 16, 18, 21
- Musical/rhythmic learners: activities - 9, 13, 14,
- Interpersonal learners: activities - 3, 5, 6, 8, 9, 14, 19, 21
- Intrapersonal learners: activities - 1, 2, 4, 11, 12, 15, 20, 21
- Naturalist learners: activities - 1, 2, 5, 6, 8, 9, 10, 11, 12, 13, 16
### Learning activities

<table>
<thead>
<tr>
<th>Activity 1( Individual )</th>
<th>Intelligences focussed in the learning activities</th>
</tr>
</thead>
</table>
| Carefully read the front part modifications of the three layers of the eye for light penetration and label them in the given diagram. | Focused Intelligences:  
Visual/Spatial  
Verbal/Linguistic  
and  
Mathematical/Logical Intelligences  

Additional Intelligences:  
Intrapersonal and  
Naturalistic Intelligences |

---

#### The sclerotic coat - cornea
This tough layer creates the "white" of the eye except in the front where it forms the transparent **cornea**. The cornea admits light to the interior of the eye. Cornea which is convex in shape and transparent as
glass, is found in front of the eye. The continuation of cornea seen in white colour is called sclera. It is this strong layer that gives shape to the eye ball.

**The choroid coat – iris, pupil**

This middle layer is deeply pigmented with melanin. The choroid coat forms the **iris** in the front of the eye. This, too, is pigmented and is responsible for eye "colour". The size of its opening, the **pupil**, is variable. In dim light, the pupil opens wider letting more light into the eye. In bright light the pupil closes down. This not only reduces the amount of light entering the eye but also improves its image-forming ability.

**The retina**

The retina is the inner layer of the eye. It contains the light receptors, the rods and cones (and thus serves as the "film" of the eye).

**Teacher consolidates** by using power point slides.
Activity 2 (Group)
Observe the given diagram, discuss and find out: Is the colour of iris same in all people around the world. What could be the reason for this?

Teacher consolidates
The choroid coat is deeply pigmented with melanin which forms the iris in the front of the eye. This, too, is pigmented and is responsible for eye "colour".

Activity: 3
Observe position of pupil in the diagram given below. This is the only way through which light can reach the retina.

Focused Intelligences:
Visual/Spatial, Naturalistic and Mathematical-Logical Intelligences

Additional Intelligences:
Intrapersonal and Verbal/Linguistic Intelligences

Focused Intelligences:
Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences
• What happens to your eyes when you go from bright sunlight into a dark room? How does your vision change?
• Did your eyes feel differently when the lights were on? Off
• Observe the eyes of your friend and find out how the size of the pupil changes with the intensity of light.
• The pupil constricts in bright light and dilates in dim light. Why does this happen?

Observe the figure given below.

Additional Intelligences: Interpersonal, Intrapersonal and Naturalistic Intelligences
• Which muscles help in this process? When the circular muscles contract, the size of the pupil decreases. What happens if the radial muscles contract?
• Stand in front of the mirror in a darkroom. Turn off the light for several minutes. When you turn it back on, observe the iris in your eye. How fast does it change shape to react to the light?

Teacher consolidates the working of the pupil with an animated picture

This adjustment is done by two sets of muscles in the iris:
• It’s circular muscles contract to close up the iris, making the pupil smaller –
• While it’s radial muscles contract to open up the iris, making the pupil larger.
• Remember this is a reflex action, like blinking - fast and automatic, with no time wasted in thinking.

Activity: 4
Observe the lens in the eye (figure). Which type of lens is this?

Focused Intelligences:
Visual/Spatial,
Mathematical-Logical
Intelligences
Teacher consolidates: The Lens

The transparent, double convex (outward curve on both sides) structure suspended between the aqueous and vitreous humours helps to focus light on the retina. The lens is made of a substance which has elasticity.

Activity: 5

Compare the pictures of two types of lenses with the lenses provided.

1. Identify the 1st and 2nd lenses.

2. What is the important characteristic that you select to differentiate these two?

3. By using a lighted candle and a screen find out the

Additional Intelligences:  
Intrapersonal and Naturalistic Intelligences

Focused Intelligences:  
Visual/Spatial, Mathematical/Logical and Bodily/Kinesthetic Intelligences

Additional Intelligences:  
Naturalistic, Interpersonal and Musical/Rhythmical Intelligences
changes happened to the light rays.

**Teacher Consolidates : Lenses**

Refraction

**Teacher explains** the changing path of the light through different media with the help of the animated diagram along with the music having different rhythms.

**Activity: 6 (Group)**

Dispersion of light through a glass prism. Do the activity by using the prism, lighted candle and screen provided.

**Dispersion:** The separation of light into colours arranged according to their frequency, by interaction with a prism or diffraction grating.
Dispersion of light in nature

Teacher consolidates by using animation of changing the path of light with music

Rules For Converging Lenses

Observe the figure and try to frame the rules for the converging lenses.
1) Any incident ray travelling parallel to the principal axis of a converging lens will refract through the lens and travel through the focal point on the opposite side of the lens.

2) Any incident ray travelling through the focal point on the way to the lens will refract through the lens and travel parallel to the principal axis.

3) An incident ray which passes through the centre of the lens will in effect continue in the same direction that it had when it entered the lens.

**Activity: 7**

Observe the diagram given below and find out the media through which the light passes to get focused in the retina.

**Focused Intelligences:**

*Visual/Spatial and Mathematical/Logical Intelligences*
Activity 8

Use the lens to make a picture of the light source. Start with the lens up close to the screen, and slowly move it away from the screen and toward the light source. Watch the pattern of light on the paper. When the lens is the right distance from the screen, there'll be a picture of the light source.

Do the above experiment and find out:

1. The lens that is used in the experiment.
2. Size of the image.
3. Nature of the image i.e., erect or upside down

Teacher Consolidates

- Light moves in straight lines. Whenever a light ray encounters a surface of a different transparent medium it bends (refracts) and heads off in another direction.
- The amount of bending depends on the nature of the transparent substance, the angle at which the light hits the surface, and the colour of the light.

Focused Intelligences: Visual/Spatial, Mathematical/Logical and Bodily/Kinaesthetic Intelligences

Additional Intelligences: Naturalistic, Interpersonal and Intelligences
• On a curved surface such as a lens, parallel rays of light will hit the surface at different angles and will be bent differently. A greater curvature will lead to a greater difference in the amount of bending.

Activity: 9

Observe the diagram below and find out:

• Nature and size of the image formed in the eye.
• The lens which is present in the eye.
• The part of the eye where the image is formed.

Teacher consolidates by using the animated picture with music according to the changes in the light rays.

• The outside of an eyeball is white, except for the clear, bulging cornea in front.
• Just behind the cornea is the iris, a coloured area with a hole in the centre called the pupil. Circular muscle tissue in the iris allows it to open and close the pupil to regulate the amount of light that gets inside the eyeball.

Focused Intelligences:
Musical/Rhythmical
Visual/Spatial and
Mathematical/Logic al Intelligences

Additional Intelligences:
Intra personal, Naturalistic and Intelligences
• Just behind the iris and pupil is the lens. The cornea and the lens work together to focus images on the retina, the light-sensitive layer that lines the inside of the eyeball.

• When the eye focuses on an object, all the light rays from a single point on that object are bent toward a single point on the retina.

• In the eyeball, light rays passing through the cornea are bent by its curvature toward the pupil. The lens flexes to change its curvature and finish the focusing process.

• The image projected on the retina is upside down because of the way the rays of light are bent by a double-convex lens.

**Activity:10**

By using the magnifying glass try to make an image of a tree on a sunny day. Hold the lens between the tree and a piece of paper. Move the lens to just the right spot. There’s an image of the tree. That image is made of light. Describe what’s Going On?

**Teacher Consolidates**

• Sunlight bounces off the tree and spreads out in all directions. The lens gathers the light shining out in all directions from each spot on that tree and bends that light so it all comes back together on a single spot on the piece of paper.

**Focused Intelligences:**

*Mathematical/Logic al Visual/Spatial, and Bodily/ kinaesthetic Intelligences*
- So light shining from a leaf at the top of the tree ends up on one spot on the paper. Light shining from a spot on the tree’s trunk ends up in a different spot on the paper. All these spots of light blend together in your eye to make an image.
- The lens is shaped to bend light rays so that they come together and then spread apart to make an image.
- The lens of the magnifying glass is fat in the middle and thin at the edges. If we took the lens out of the magnifying glass, it would look like this:

![Diagram of a lens](image)

The surface of this lens is curved. It’s that curve that makes light bend when it shines through the lens

**Activity:** 11

Observe the diagram below and find out:

**Additional Intelligences:**
- Naturalistic,
- Interpersonal, and
- Verbal/Linguistic Intelligences
1. The structures by which the lens gets attached to the eye wall.

2. Which layer is modified in to ciliary muscles?

3. Name the chamber enclosed by the lens and cornea.

4. Name the fluid filled in this chamber?

5. Name the chamber enclosed by the lens and retina.

6. Find out the structure that divides the space in the eye ball into two?

Teacher Consolidates

- The lens is connected to the ciliary muscles with the help of ligaments.
- The chamber seen just behind the cornea is the aqueous chamber. The fluid filled in that chamber is called the aqueous humour. As

Focused Intelligences:
Visual/Spatial and Mathematical/Logical Intelligences

Additional Intelligences:
Intrapersonal and Naturalistic Intelligences
opposed to the vitreous humour, the aqueous humour (as its name suggests) is a clear watery fluid.

- This fluid which gets separated from the blood gets absorbed back into the blood in the same quantity. This fluid provides nourishment and oxygen to the cells around it. It also helps to give the eye shape, and protection.

**Activity :12**

Note the change in curvature of the lens, ciliary muscles and suspensory ligaments with the focusing of near and distant objects

---

**Focused Intelligences:**
- Visual/Spatial, and
- Mathematical/Logical Intelligences

**Additional Intelligences:**
- Naturalistic and
- Intrapersonal Intelligences
Teacher Consolidates by using animated picture with music having appropriate changes in the rhythm.

Suspensory Ligaments: These are elastic-like structures present in the eye that suspend the lens and pull it into shape for focusing distant objects onto the retina.

Ciliary Body

- For nearer objects the lens is increasingly rounded by ciliary muscle contraction, which relaxes the suspensory ligament
- When the ciliary muscles are relaxed, the perimeter of the lens is pulled outwards giving it a flattened shape.
• The ciliary body projections are responsible for the secretion of the aqueous humour.

**Activity :13**

Dramatise with music the changes in curvature of the lens, ciliary muscles and suspensory ligaments with the focusing of near and distant objects.

**Accommodation.**

When light travels to the eye from a distant object, the rays are almost parallel and need to be bent very little to be brought to a focus. So when viewing a distant object, the lens must be made thinner and less convex. This is done by:

- Relaxing the ciliary muscles
- Stretching the suspensory ligaments, and
- Increasing the muscular tension on the lens.

When light travels from a near object the rays are going away from each other and need to bend a lot more to be brought to a focus. So when viewing a near object the lens needs to be made fatter and more convex. This is done by:

- Contracting the ciliary muscles

**Focused Intelligences:**

Musical/Rhythmical
Bodily/kinaesthetic
Visual-Spatial and
Mathematical-Logical
Intelligences

**Additional Intelligences:**

Interpersonal, Naturalistic and
Verbal/Linguistic
Intelligences
• Slackening the suspensory ligaments, and
• Reducing the muscular tension on the lens.

The lens's ability to change its shape to focus near and distant objects is called accommodation. In addition to the contractions of the ciliary muscles, the curvature of the cornea, shape of the pupil and the fluids in the eye also help in this process.

**Activity: 14**
Observe the given diagram and make a flow chart showing the pathway of light in the eye and make a song and tune it appropriately.

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**Teacher Consolidates** by using an animated picture with music

**Perceiving Light**

• When light enters the eye, it first passes through the cornea, then the aqueous humor, lens and vitreous humor.
• Ultimately it reaches the retina, which is the light-sensing structure of the eye. The retina contains two types of cells, called rods and cones.
• Rods handle vision in low light, and cones handle

---

**Focused Intelligences:**
Musical/Rhythmical,
Visual/Spatial,
Bodily/Kinaesthetic and
Mathematical/Logical Intelligences

**Additional Intelligences:**
Interpersonal,
Naturalistic and
Verbal/Linguistic Intelligences
colour vision and detail. When light contacts these two types of cells, a series of complex chemical reactions occurs.

- The chemical that is formed (activated rhodopsin) creates electrical impulses in the optic nerve.

Finally, the brain puts these different signals from different photoreceptors together into an image.

**Activity 15**

Below is an example of a rod and a cone. Compare the external structure and arrangement of these in the retina.

**Focused Intelligences:**

*Visual/Spatial, and Mathematical/Logical Intelligences*

**Additional Intelligences:**

*Naturalistic and Interpersonal Intelligences*
Teacher Consolidates: The chemistry of vision

- Photoreceptors such as rod cells and cone cells are present in the retina. The outer segment of rods are long and thin, whereas the outer segment of cones are more, well, cone shaped.
- Rod cells get stimulated in dim light. Thus it helps the vision in dim light. But cone cells get stimulated only in bright light. The cone cells help to distinguish colours and to see the objects in bright light.
- The outer segment of a rod or a cone contains the photosensitive chemicals. In rods, this chemical is called rhodopsin; in cones, these chemicals are called colour pigments. The retina contains 100 million rods and 7 million cones. The retina is lined with black pigment called melanin -- just as the inside of a camera is black -- to lessen the amount of reflection.

Activity: 16

On a dark evening, go outside into your backyard and try to look at familiar objects. Can you see them better if you look straight at them or if you look just to the side of them? Why do you suppose that is?

Observe the retinal layer and identify the different regions in relation with presence and absence of rods and cones.

Focused Intelligences: Mathematical/Logical, Visual/Spatial, and Bodily/Kinaesthetic Intelligences
Teacher consolidates

On the retina are two kinds of cells that change light into nerve impulses. Rod cells do not see colour but are best for night viewing because they react to very low light levels.

Cone cells are for colour viewing. They work best in good light and are found mostly in the centre of the retina, an area called the **macula**, which provides the sharpest vision.

Within each eye is a small **blind spot** with no rods or cones, where the optic nerve is attached to the eyeball. The optic nerve collects the nerve impulses and carries them to the brain, which interprets them as an image.
# Regions of the Retina

- **Macula**
  The small, sensitive area of the central retina which provides vision for fine work and reading.
  The macula is responsible for the sharp, clear vision that occurs when we look directly at something. It has a high density of cones which are the photoreceptors concerned with colour and enable high quality vision. The most sensitive region of the macula is the fovea.

- The rest of the retina's surface handles our peripheral vision, and this is where most of the rod photoreceptors of the retina are located.
  Have you ever noticed how we can often see things more sharply in faint light if we do not look at them directly?

  This is because the rods are designed for vision in dim light. However for images seen in bright light, we use the central retinal region (the macula) for a sharper focus when we look directly at the image, as the cones detect detail brilliantly.

  In people over sixty, the most common cause of blindness is macular degeneration, in which the macula becomes covered with scar tissue and vision is obscured.
### Activity: 17

Differentiate between Fovea, Blind Spot.

- **Fovea**
  
The fovea is the most central part of the macula and provides the sharpest of sharp vision. It boasts the highest concentration of cones and therefore the highest acuity. Because of the fovea we achieve the sharpest day vision however by looking straight at the object of interest. Humans actually move their eyes so that images of interest are projected onto their foveas.

- **Blind Spot**
  
The blind spot is a small area of the retina where the optic nerve actually enters the eye, this occurs normally in all eyes. It results in a gap in the visual field which corresponds to an area of the retina where no visual cells are present. However, you are not aware of this blind spot because each eye covers for the blind spot of the other eye. The spot where the optic nerve and blood vessels exit the retina is called the optic disk. This area is a blind spot on the retina because there are no rods or cones at that location.

### Focused Intelligences:

- Mathematical/Logic
- and Visual/Spatial,
- Intelligences
**Activity 18**
Do this: Here is an image to show your blind spot.
Close your right eye. With your left eye, look at the +.
You should see the red dot in your peripheral vision.
Keep looking at the + with your left eye. The red dot will move from the left to the right and disappear and reappear as the dot moves into and out of your blind spot.

![Image of a dot and a plus sign](image)

**Activity 19**
When severe vitamin A deficiency is present, then night blindness occurs. Discuss and find out reasons.

**Teacher Consolidates**

**Vitamin A Deficiency**

The pigment seen in the rod cells is rhodopsin. When light falls on it, rhodopsin dissociates. The impulses formed as a result are received as a stimulus by the nerve cells. Retinine, which is the part of the rhodopsin, is synthesized from Vitamin A. Thus the deficiency of vitamin A causes Night blindness

When the levels of light-sensitive molecules are low due to vitamin A deficiency, there may not be enough light at night to permit vision. During daylight, there is enough light stimulation to produce vision despite

**Focused Intelligences:**
- Mathematical/Logical
- Visual/Spatial

**Additional Intelligences:**
- Interpersonal,
- Naturalistic and
- Verbal/Linguistic

**Focused Intelligences:**
- Mathematical/Logical and
- Visual/Spatial

**Intelligences**
low levels of retinal Retinine.

**Activity: 20**

Can you name the parts of the eye?

**Human Eye: In and Out of Focus**

Test different people to find out what makes an object look blurry in their eyes.

**Main Activity:** As an object approaches, the human

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<tr>
<td>Mathematical/Logical</td>
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<tr>
<td>Visual/Spatial and Bodily/kinaesthetic</td>
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eye's lens flexes to focus on it. Eventually the object gets so close, however, that the lens can no longer focus on it. Then the object begins to blur. How close can you bring an object before it looks blurry? Does this distance vary for different people or age groups? Does the shape or colour of the object make any difference? Does it matter how brightly the object is illuminated?

Materials

- a 2.5-cm x 5-cm (1"x 2") swatch of printed words from a newspaper or magazine
- modelling clay or sculpting compound
- a 3" x 5" index card
- a cloth or soft vinyl tape measure like those used in sewing (CAUTION: Do not use any sharp or pointed objects, including wooden or plastic rulers, since these materials will be held close to students' faces.)

1. Glue or paste the newspaper or magazine selection in the centre of the 3" x 5" card.

2. Roll the clay into a 5-cm (2") ball and mount the 3" x 5" card in it.

3. For the first test, have the test subject cover one eye with a hand.

4. Slowly bring the clay ball and words directly
toward the test subject's uncovered eye. The test subject should try to focus on the words.

5. The test subject should say "stop" when she or he can no longer focus clearly on the words. Stop moving the ball at that point.

6. Have the test subject hold one end of the tape measure to her or his cheekbone just below the eye and measure the distance to the 3" x 5" card. (NOTE: Having the test subjects measure the distances helps ensure that no eyes get poked.)

7. Write down the measurement. Be sure to include whether or not the test subject wears glasses or contact lenses.

8. Repeat the test several times, using different test subjects and testing different variables. For example, try the test with both eyes uncovered, with and without glasses, with different amounts of light, and so on. Just remember to change only one variable for each test and to repeat each test at least once. Average the results of repeated tests.

Questions

1. What is the average distance where the image begins to blur for all test subjects? Is the average distance larger or smaller for people who wear glasses? Is it larger or smaller for
<table>
<thead>
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<th>Question</th>
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<tbody>
<tr>
<td>1. Can you determine if you can focus on objects with only one eye or both</td>
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<td>eyes? Is the distance the same for both eyes of the same person?</td>
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<tr>
<td>2. Can you design another experiment that tests how wide a person's field</td>
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<td>of vision is?</td>
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Lesson Plan No: 3

Lesson Title: *Working of the Eyes*

Lesson Objectives:

The pupil:

1. Differentiating between monocular and binocular vision.
2. Analysing the advantages of having two eyes instead of just one.
3. Creating the idea that two eyes are needed for "stereoscopic" or 3-D vision.
4. Applying knowledge in finding out reasons for some animals' eyes on the sides of the head rather than in the front.
5. Comparing and find out the advantages of both binocular and monocular vision.
6. Analysing the reasons for the eye defect ‘squint’.
7. Creating that as daylight fades or as room lights dim, colours become hard to identify.
8. Applying knowledge in finding out reasons for as daylight fades or as room lights dim, colours become hard to identify.
9. Comparing the importance of rods and cones in colour vision.
10. Analysing the reasons for the eye defect “colour blind.”
11. Creating the role of 3 types of cones in colour vision
12. Applying knowledge in finding out reasons for some animals see only in black and white.
13. Evaluating the statement we do not “see” with our eyes but, rather, with our brains. Our eyes merely are the beginnings of the visual process.
14. Analysing the path way of impulse transmission from the eyes to the brain.
15. Creating what happens if there is damage to the visual pathway.
16. Measuring the angles of complete visual field and central visual field.

17. Finding out how does peripheral vision work, and how does it help us to see well.

18. Experimenting and finds out Can we read something off to the side, while keeping our eyes pointed forward.

19. Comparing the eye to a camera and finds out the similarities and differences.

20. Analysing that the cerebrum makes the vision a reality.

21. Creating how the brain turns a 2-dimensional image into a 3-dimensional image.

22. Exchanging short messages in Braille.

23. Comparing the human eye to the other two kinds of eyes from different organisms

24. Applying knowledge in finding out reasons for why does the eagle have great visual acuity?

25. Applying knowledge in finding out reasons for what is the purpose of the reflector found at the back of the cat’s eye?

Intelligences Focused in Various Activities

- Verbal-linguistic learners: - all activities
- Mathematical-logical learners: - all activities
- Visual-spatial learners: - all activities
- Bodily-kinaesthetic learners: -1,2,4,11,12,15,19,22
- Musical-rhythmic learners: -3,5,6,8,13,20
- Interpersonal learners: -1,2,3,4,5,6,8,13,14,17
- Intrapersonal learners: -1,10,11,12,14,15,16
- Naturalist learners: -1,2,3,4,5,7,8,13,14,18,21
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<tr>
<th>Learning activities</th>
<th>Intelligences focussed in the learning activities</th>
</tr>
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<tr>
<td><strong>Activity: 1</strong></td>
<td>Focused Intelligences: Naturalistic, Visual/Spatial and Mathematical/Logical Intelligences</td>
</tr>
<tr>
<td>Observe the pictures given below. Discuss and find out:</td>
<td>Additional Intelligence: Interpersonal Intelligence</td>
</tr>
</tbody>
</table>

1. Why do we have two eyes?
2. Why are they placed where they are on our head?
3. Do all animals that see have two eyes?
4. Why are some animals' eyes on the side of the head rather than in the front?
5. Is there any advantages of having two eyes instead of just one?
6. Is it easier to judge distances with one eye or two?
7. Two eyes are needed for "stereoscopic" or 3-D vision. Why do you think this is so?

**Do the following activity (Individual)**

- Stand holding a pencil in each hand.
- Raise the arms straight in front at shoulder height.
- Close one eye and try to bring the ends of the two pencils together.
• Try the activity again with both eyes open.

**Group activity**

• Stand in pairs facing each other about two arms-lengths apart.

• Cover the right eyes with the right hands and then raise the left arms and try to touch each other's pointer fingers.

• Try again with the left eye covered and finally with both eyes open.

**Discuss the following questions**

1. Did you notice any difference between using one eye as opposed to two eyes?

2. What types of activities would be more difficult to do with only one eye?

**Teacher consolidates: Monocular And Binocular Vision**

• Humans are able to see with both eyes. We call this binocular vision. Both the left and right eye send signals to the brain, producing one picture.

• Some animal species have one-eyed vision, or monocular vision, which means their eyes see the world separately and produce two pictures rather than one. Animals, such as birds, have monocular vision because their eyes are on opposite sides of the face and point in opposite directions.

• The binocular vision helps us to calculate the distance from objects correctly. It is obtained since

**and**

*Mathematical/Logical Intelligences*

**Additional Intelligences used:**

*Intrapersonal and Naturalistic Intelligences*

**Focused Intelligences:**

*Visual/Spatial and Mathematical/Logical Intelligences*

**Additional Intelligences used**

*Interpersonal and, Naturalistic, Intelligences*
it is possible to concentrate both eyes on a single object. It is the cerebrum which coordinates the images formed in both the eyes. Depth perception and judging how near or far objects are easier with two eyes.

Activity: 2

Find out:

- Close one eye and try to replace the cap of a pen which is held by another person.
- Though the image of an object is formed in both the eyes we do not feel it as two separate images. What is the reason behind?
- What is the difference between the vision through a single eye and a pair of eyes?
- Try to compare and find out the advantages of both binocular and monocular vision.

Teacher Consolidates by using pictures.

The balanced movement of the two eyes is made possible by the muscles of the eyeball. Note the three pairs of muscles which connect the eye to the walls of the eye sockets.

Activity: 3

Observe the diagram given below, discuss and find out:

The reason for this eye defect.
Logical Intelligences

Additional Intelligences used:

Interpersonal, Naturalistic, and Verbal/Linguistic Intelligences
**Teacher Consolidates** by using an animated picture along with music to represent the function of each eye muscle. This condition is called squint. A “squint” is the common name for ‘strabismus’ or ‘heterotropia’ which is the medical term used to describe eyes that are not pointing in the same direction, or which are misaligned.

Squints are also sometimes called 'lazy eye', to refer to a turned eye, but this is not an accurate description. Squints can be classified according to the direction of the turn of the eye:

- **Esotropia** (convergent) refers to an eye that turns inwards towards the nose;
- **Exotropia** (divergent) refers to an eye that points outwards;
- **Hypertropia** is when eye is upwards.

Binocular vision occurs when both eyes are looking towards the same direction, to produce a single, combined image at the brain. Early detection of this disorder can be rectified by a careful surgery.

**Activity:4**

Do this activity:

1. Change the colour scheme on the colour television. Try different colours. Try black and white. Can you see as much detail on the black-and-white screen? Find out the reason.

2. Close the windows and pull down the curtains. Now try to identify the colours.

**Focused Intelligences:**

*Bodily/Kinaesthetic Visual/Spatial and Mathematical/Logical Intelligences*
3. Have you noticed that as daylight fades or as room lights dim, colours become hard to identify? What is the reason? Discuss and find out.

**Teacher Consolidates**

- Cones are most sensitive to one of three different colours (green, red or blue). Signals from the cones are sent to the brain which then translates these messages into the perception of colour.

- Cones, however, work only in bright light. That's why you cannot see colour very well in dark places. So, the cones are used for colour vision and are better suited for detecting fine details. There are about 6 million cones in the human retina.

**Activity:5**

Some people cannot tell some colours from others - these people are "colour blind."

Analyze the graph below and try to find out the reasons for this eye defect.

**Pigment Anatomy**

3 types of cones: short (S), middle (M), and long (L) wavelength sensitive.

(S): 430 nm = blue
Teacher consolidates by using the animated diagram with different music for different colours

- Observe the cone cells. There are different types of cone cells to recognize the primary colours viz blue, green and red. They contain different types of a pigment called iodopsin which helps us to recognize the primary colours. Damages in any of these cone cells may cause inability to distinguish colours. This is called colour blindness.

- Someone who is colour blind does not have a particular type of cone in the retina or one type of cone may be weak. In the general population, about 8% of all males are colour blind and about 0.5% of all females are colour blind.

Activity: 6

How do we see colours? By analyzing the clues given below construct a flow diagram and based on it compose a song with appropriate rhythms to show each step of the colour vision in human beings.

Focused Intelligences:
Musical/
Rhythmical
Visual/Spatial and
Mathematical/
Logical
Intelligences
- Cones more concentrated near fovea
- Adapts to a wide range of illumination colours and levels.
- Rods spread throughout the retina
- Provide quick response to changes in illumination

Measuring Wavelengths: Short wavelengths cause the green receptor to fire. As the wavelength gets longer and closer to 580 nm the Red begins to fire, surpassing the green. Get mix of wavelengths.

Additional Intelligences:
Interpersonal and Verbal/Linguistic Intelligences
Teacher consolidates

Therefore, colour vision is the consequence of unequal stimulation of the 3 types of cones. In a specific ratio. Example: if you stimulate all 3 types of cones about equally the result is **white or no colour**

**Colour Blindness : Three types**

There are three main kinds of colour vision defects. *Red-green colour vision defects* are the most common. This type occurs in men more than in women. The other major types are *blue-yellow colour vision defects* and a *complete absence of colour vision*. Most of the time, colour blindness is genetic.
Activity: 7
Discuss and find out:
Why do some animals see in black and white?

Teacher consolidates
Many animals are nocturnal, and have increased amounts of rods in their optical systems. The cones that control colour vision, are really unnecessary or are needed in extremely small quantities.

Activity: 8
Suppose you’re looking out the window on a sunny day and you see a tree. How does light let you see the tree? Trace the path of light through the eye.

Teacher Consolidates each point with the animated diagram accompanying with appropriate changes in the rhythm at each stage.

Process of Vision

- Light waves from an object (such as a tree) enter the eye first through the cornea. The light then progresses through the pupil, the circular opening in the centre of the coloured iris.
- Fluctuations in incoming light change the size of the

Focused Intelligences:
Naturalistic and Mathematical/Logical Intelligences

Focused Intelligences:
Musical/Rhythmical
Visual/Spatial and Mathematical/Logical Intelligences

Additional Intelligences:
Interpersonal, Naturalistic and Verbal/Linguistic Intelligences
eye’s pupil. When the light entering the eye is bright enough, the pupil will constrict.

- Initially, the light waves are bent or converged first by the cornea, and then further by the crystalline lens to a nodal point (N) located immediately behind the back surface of the lens. At that point, the image becomes reversed and inverted.

- The light continues through the vitreous humor, and then, ideally, back to a clear focus on the retina, behind the vitreous. The small central area of the retina is the macula, which provides the best vision of any area in the retina.

- Within the layers of the retina, light impulses are changed into electrical signals. Then they are sent through the optic nerve, along the visual pathway, to the occipital cortex at the posterior (back) of the brain. Here, the electrical signals are interpreted or “seen” by the brain as a visual image.

_Actually, then, we do not “see” with our eyes but, rather, with our brains. Our eyes merely are the beginnings of the visual process._

**Activity:9**

Observe the diagram given below and find out the pathway of impulse transmission from the eyes to the brain.

**Focused Intelligences:**

*Visual/Spatial and Mathematical/Logical Intelligences*
**Teacher Consolidates**

- Within the optic nerve, a defined group of axons from each eye crosses over to join the opposite optic nerve at the optic chiasma (see Figure), so each side of the brain receives visual information from both eyes.

- After the chiasma, retinal axons go to one of three areas: two of these are in the midbrain and one is in the thalamus. The information going to the midbrain does not reach conscious levels but rather produces pupillary reflexes and eye movements.

**Activity: 10**

Observe the diagram and find out:

What happens if there is damage to the visual pathway? Different visual problems will occur depending on where the damage is. The black bars (labeled 1 through 5) indicate where damage may occur and the chart to the right

---

**Additional Intelligences:**
- Intrapersonal
- Verbal/Linguistic

**Focused Intelligences:**
- Visual/Spatial
- Mathematical/Logical
of the pathway indicates the resulting "blind" area (gray shading) of the visual field. Write down your observations.

**Teacher Consolidates** by using the animated picture

**Damage at site #1:** this would be like losing sight in the left eye. The entire left optic nerve would be cut and there would be a total loss of vision from the left eye.

**Damage at site #2:** partial damage to the left optic nerve. Here, information from the nasal visual field of the left eye (temporal part of the left retina) is lost.

**Damage at site #3:** the optic chiasm would be damaged. In this case, the temporal (lateral) portions of the visual field would be lost. The crossing fibres are cut in this example.

**Damage at site #4 and #5:** damage to the optic tract (#4) or the fibre tract from the lateral geniculate to the cortex (#5) can cause identical visual loss. In this case, loss of vision of the right side. Partial damage to these fibre tracts can cause other predictable visual problems.

**Activity: 11**
Read the definitions, and then label the eye anatomy diagram below.

**Cornea** - the clear, dome-shaped tissue covering the front of the eye.

**Iris** - the coloured part of the eye - it controls the amount of light that enters the eye by changing the size of the pupil

**Lens** - a crystalline structure located just behind the iris - it focuses light onto the retina

**Optic nerve** - the nerve that transmits electrical impulses from the retina to the brain

**Pupil** - the opening in the centre of the iris - it changes size as the amount of light changes (the more light, the smaller the hole)

**Retina** - sensory tissue that lines the back of the eye. It contains millions of photoreceptors (rods and cones) that convert light rays into electrical impulses that are relayed to the brain via the optic nerve

**Vitreous humor** - a thick, transparent liquid that fills the centre of the eye - it is mostly water and gives the eye its form and shape
Observe the puzzle and clues, and then fill in the blanks. The clues are below the puzzle. Give a try.

**Focused Intelligences:**
- Bodily/Kinaesthetic
- Visual/Spatial and Mathematical/Logical Intelligences

**Additional Intelligences:**
- Intrapersonal and Verbal/Linguistic Intelligences

---

**Clues**

**ACROSS**
1. Cortical lobe that receives visual information
3. The absence of sight
5. Transparent outer coat of the eyeball
9. Muscles that control the size of the pupil
10. Photoreceptor for color vision

**DOWN**
1. Where axons of retina leave the eye (2 words)
2. Focuses light
4. Contains photoreceptors
6. Photoreceptor used in dim light
7. The process of seeing
8. Central region of the retina

Teacher Consolidates
Activity: 13

- Analyze the diagram given below and measure the angles of Complete visual field and Central visual field.

- Discuss and find out how does peripheral vision work, and how does it help us to see well?

**Complete visual field and central visual field.**

The complete visual field is the entire area in front of the eyes from the end of one lateral dashed line to the other.

Teacher consolidates using the animated diagram with music appropriate to each visual field.

**Focused Intelligences:**
- Musical/
- Rhythmical
- Visual/Spatial and
- Mathematical/Logical Intelligences

**Additional Intelligences:**
- Interpersonal,
- Naturalistic, and
- Verbal/Linguistic Intelligences
**Peripheral Vision**

- The visual field is defined as the view seen by the two eyes while looking straight ahead. Without moving eyes or head, a person can see details (well enough to read) within a limited angle drawn from a point between the eyes on the forehead and two experimentally determined points to the left and right in front of the viewer, at proper focal distance. Humans can generally see objects in a 180 degree semi-circle in front of us.

- In addition to the area of clear or central vision, we can see objects and movements to the sides of our heads, although as the distance around to the sides increases, it becomes more difficult to identify objects.

---

**Activity: 14**

Experiment and find out the solution: How good is this “side vision”? Can you read something off to the side, while keeping your eyes pointed forward?

- Eyes are able to focus on one thing while still

**Focused Intelligences:**

Visual/Spatial, Bodily/Kinaesthetic
perceiving the world to either side. Sometimes we look directly at an object, as when we read or when we shoot a basketball toward the hoop.

- But we use peripheral vision as well—we can detect things to our sides even while we are looking straight ahead.

- The area of central vision includes objects whose images fall onto the central area of the retina, the macula, and especially the fovea.

- Cones in all other areas of the retina are in the periphery, and while they convey visual information, they do not provide the resolving power of the densely packed fovea.

**Activity :15**

Identify the parts of the eyes and fill the table given below after carefully read the functions of the each part of the eye

<table>
<thead>
<tr>
<th>PARTS OF THE EYE</th>
<th>Mathematical/Logical Intelligences</th>
<th>Additional Intelligences: Interpersonal, Intrapersonal, Verbal/Linguistic and Naturalistic Intelligences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sclera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Cornea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Choroid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Scleral body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Iris</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Pupil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Retina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Macula</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Optic disc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Optic nerve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Vitrous humor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Aqueous humor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Canal of Schlemm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Lens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Conjunctiva</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Focused Intelligences:**

Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences

**Additional Intelligences:**

Intrapersonal and Verbal/Linguistic Intelligences
<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>clear watery fluid found in</td>
<td>clear watery fluid found in the anterior chamber of the eye; maintains pressure and nourishes the cornea and lens</td>
</tr>
<tr>
<td>small area of the retina</td>
<td>small area of the retina where the optic nerve leaves the eye: any image falling here will not be seen</td>
</tr>
<tr>
<td>involuntary muscles</td>
<td>involuntary muscles that change the lens shape to allow focusing images of objects at different distances</td>
</tr>
<tr>
<td>transparent tissue</td>
<td>transparent tissue covering the front of the eye: does not have blood vessels; does have nerves</td>
</tr>
<tr>
<td>photoreceptors</td>
<td>photoreceptors responsive to colour and in bright conditions; used for fine detail</td>
</tr>
<tr>
<td>photoreceptors</td>
<td>photoreceptors responsive in low light conditions; not useful for fine detail</td>
</tr>
<tr>
<td>central part of the macula</td>
<td>central part of the macula that provides sharpest vision; contains only cones</td>
</tr>
<tr>
<td>transparent tissue</td>
<td>transparent tissue that bends light passing through the eye: to focus light, the lens can change shape</td>
</tr>
<tr>
<td>small central area of the</td>
<td>small central area of the retina that provides vision for fine work and reading</td>
</tr>
<tr>
<td>retina</td>
<td>bundle of over one million axons from ganglion cells that carry visual signals from the eye to the brain</td>
</tr>
<tr>
<td>hole in the center of the</td>
<td>hole in the center of the eye where light passes through</td>
</tr>
<tr>
<td>eye</td>
<td>layer of tissue on the back portion of the eye that contains cells responsive to light (photoreceptors)</td>
</tr>
</tbody>
</table>
Activity: 16

Even though the eye is much more complex than a camera, they share a lot of similarities. Compare the eye to a camera and tabulate the similarities and differences in your groups.

Teacher Consolidates: The Eye as a Camera

- Think of the eye as a camera. A camera needs a lens and a film to produce an image. In the same way, the eyeball needs a lens (cornea, crystalline lens, vitreous) to refract, or focus the light and a film (retina) on which to focus the rays.

- The retina represents the film in our camera. It captures the image and sends it to the brain to be developed. The macula is the highly sensitive area of the retina. We use our macula to read or to stare intently at an object.

<table>
<thead>
<tr>
<th>EYE</th>
<th>CAMERA</th>
</tr>
</thead>
<tbody>
<tr>
<td>The lens and cornea focus light onto the back of the retina.</td>
<td>The lens focuses light onto a light-sensitive surface called film.</td>
</tr>
</tbody>
</table>
Muscles change the shape of the lens to focus the image. The lens of a camera can be moved back or forward to focus images.

The muscles in the iris regulate the amount of light that reaches the retina. The aperture, like the iris, regulates the amount of light that reaches the retina.

As light enters the eye and passes through the lens and cornea, it refracts or bends. When the light refracts, it turns the image upside down and backward onto the retina. Light that enters the camera refracts and turns images upside down and backward onto the film.

**Activity 17**

Though the image formed in the retina is inverted, do we feel it is our vision? Find out the reason. Observe the diagram and find out how the image is interpreted.

**Teacher consolidates** using the animated diagram with the following **Focused Intelligences**:  
- Visual/Spatial,  
- Musical/Rhythmical,  
- Mathematical/Logical  

**Intelligences**
music appropriate to each step.

**The physiology of vision**

- The light which falls on the photoreceptors causes a chemical change.
- This stimulus creates impulses that travel through the optic nerve which is formed by the clustering of axons of the photoreceptors, reaches the cerebrum.
- It is the cerebrum which makes the vision a reality.

![Diagram of light source, eye receptor, brain decoder](image)

**Activity: 18**

*The funny thing is that the image on the retina appears upside-down, backwards, and 2-dimensional. But when we think about how we see things, they're always right-side-up and 3-dimensional. Something else has to happen before this journey is over...this light-information has to be sent to the brain.*

How does the brain turn a 2-dimensional image into a 3-dimensional image? Discuss and find out.

**Teacher consolidates** by using animated diagram

**Stereoscopic vision**

- In humans, eyes are several inches apart, and that gives each eye a slightly different view on the world.
• The visual field of each eye overlaps. Each eye sees the image from a slightly different angle and the brain creates a three-dimensional image. This allows the individual to perceive depth of field.

Many animals do not have overlapping fields of vision. They cannot perceive depth but they have a wider field of view. Some (birds) can perceive depth by moving their heads.

Activity 19
Activity With Braille.
Give each student a Braille card. Read the explanation together in groups. Close the eyes. Explore the number and position of the dots for each letter by touch. Next work as

Focused Intelligences:
Visual/Spatial, Musical/Rhythmical
partners. Exchange short messages in Braille by cutting out letters and gluing them onto another sheet.

**Teacher Consolidates**

- A blind person must develop her sense of touch in order to read.
- Braille is a system of raised dots representing the letters of the alphabet which was invented by Louis Braille in the nineteenth century.
- A really fast reader can scan up to 2000 dots per minute with her fingertips, an equivalent of almost 100 words per minute.

**Activity: 20**

Construct a poem and tune it based on the theme

*"Light’s Amazing Journey into the Brain"

**Teacher consolidates** the points by using the animated diagram with appropriate music

1. Light enters the eye, first passing through the outer, transparent layer of the eye, called the **cornea**.

2. Through the cornea, the light next passes through the **pupil**. The pupil gets bigger to allow more light in and smaller to allow less light in.

How does the pupil know to get bigger or smaller? That's the job of the **iris**. The iris is the coloured part of your eye, and it controls the pupil's size.

3. Once the light passes through the iris, it next hits the **lens**. The lens puts the light rays into focus and
sends it to the **retina**. But before it hits the retina, it has to pass through...

4. **VITREOUS HUMOR**!!! This is a colourless mass of jelly-like material that lives in the eye behind the lens. The light passes through this material, where it finally reaches...

5. **The retina**, which is the innermost layer of the eye. Think of the eye as a camera. The retina, then, is the film in the camera which captures the image.

The retina contains light-sensitive cells called **rods and cones**. These cells are what connect with the brain through a very important nerve at the back of the eye called...

6. **The optic nerve**. This nerve is the brain's messenger, sending the image to a place in the back of the brain called **the occipital lobe**. It’s at this point that the brain is able to switch that backwards, upside down, 2-dimensional image into its correct form.

*Oh! What a journey! Just imagine how many times a day light takes that journey through your eyes. The number would be too many times to count. It happens all the time and you don't even have to think about it. Your eyes just do it! The eye is truly amazing.*

**Activity 21**

Each pair of students will receive a picture of two different animals (Hawk, owl, fish, squid, octopus and insect) and a blank Venn diagram worksheet

**Focused Intelligences:**

*Visual/Spatial, Naturalistic and Mathematical*/
1. Compare and contrast the human eye to the other two kinds of eyes from different organisms.

2. Explain why the organism’s eyes are suited for their survival. E.g. why does the eagle have great visual acuity? What is the purpose of the reflector found at the back of the cat’s eye?

3. What are two differences between the eyes of nocturnal animals and humans? How do their eye structures compare to their function.

4. Display the Venn diagrams and share some of the differences with the rest of the class.

5. Choose any two organisms and explain how its eye anatomy affects its physiology?

**Teacher consolidates: How does the vertebrate eye operate?** The fish-like ancestor of all vertebrates had photoreceptor cells that were oriented *away* from incoming light — that is, the light-absorbing pigments were located at the "back" of the cell (away from the light) and the signal-producing part of the cell was located at the "front" (towards the light).
The eye has multiple angulated surfaces that cause light to bend. These are:

1. The interface between the air and the front of the cornea
2. The interface between the back of the cornea and the aqueous humor
3. The interface between the aqueous humor and the front of the lens
4. The interface between the back of the lens and the vitreous humor

When everything is working correctly, light makes it through these four interfaces and arrives at the retina in perfect focus. There are three kinds of colour-sensitive pigments:

Red-sensitive pigment, Green-sensitive pigment, Blue-sensitive pigment

Each cone cell has one of these pigments so that it is sensitive to that colour. The human eye can sense almost any gradation of colour when red, green and blue are mixed
Hawks, owls and other birds of prey have much more acute vision than humans.

A hawk has a much smaller eye than a human being but has lots of sensors (cones) packed into that space.

This gives a hawk vision that is eight times more acute than a human's. A hawk might have 20/2 vision!

*The owl which sleeps during the day*

Does the owl sleep during the day?

- Whether it sleeps or not, it is not able to see during day time. The reason for this is the deficiency of cone cells which give receptive power in bright light. But the presence of more rod cells gives it greater power of vision during night.

- All the animals that search for prey during night have this specialty. In birds which are active during day time the presence of rod cells is very less.

- Have you seen the eyes of cat and dog shining in the night? The reason for this is the presence of tapetum behind the eye which is a layer capable of reflecting light.

*Fish eye*

- The optical system in fish is very similar to that of the land vertebrates; however, there are some important differences. The fish has a more spherical shaped lens than the land dwellers.
• Fish focus by changing the relative distance between the lens and the retina, where as other vertebrates change the curvature of their more flexible lens.

• Fish have choroids which contain a special structure, the tapetum lucidum, and this contains very reflective guanine crystals to aid in dim light vision. This is very important because of the lowered amount of light that penetrates the fish’s watery environment.

• Additionally, many deep-sea fish have only these and rods, for increased low light sensitivity. They even have epithelial layers for the specific purpose of protection from bright light.

Invertebrate eye: Squid and octopus eye

Squid and octopus have evolved an eye layout that is remarkably similar to our own. They also have large eyes, with a lens, iris, and single large interior chamber, as shown below, which provide them with excellent vision. However, they inherited photoreceptor cells that are oriented towards the light, so that their visual nerves run
behind the retina — and hence, squid and octopus have no blind spot.

**Insect eye**

Vertebrate and insect eyes have vastly different morphology and structure, although they operate under very similar photochemical systems.

- The compound eye of most insects has many facets. Behind the corneal lens of each facet, there are functional units called ommatidium.

- The receptor cells within the ommatidium each detect a very small fraction of the spectrum of light that the eye as a whole is exposed to; like the rods and cones of the vertebrate eye. In compound eyes, the photoreception cells are called retinular cells.
Within each ommatidium, different retinular cells are sensitive to different colours due to protein variations with in the rhodopsin.

Most insects are equipped to see further along the short wavelength end of the colour spectrum, towards ultra-violet, however, they don’t see into the reds, which make up the longer wavelengths that vertebrates can see.

Arthropod eyes are called **compound eyes** because they are made up of repeating units, the **ommatidia**, each of which functions as a separate visual receptor. Each ommatidium consists of

1. a **lens** (the front surface of which makes up a single **facet**)

2. a transparent **crystalline cone**

3. light-sensitive **visual cells** arranged in a radial pattern like the sections of an orange

4. **Pigment cells** which separate the ommatidium from its neighbours.
Activity: 22

Draw a simple stereogram.

1. Draw two identical rectangles next to each other.

2. Draw a small circle in the centre of the one on the left. Draw an identical circle slightly to the left of centre in the rectangle on the right.

3. Hold the paper at arm's length or tape it to the wall and cross your eyes slightly so that the two squares exactly overlap. The circle will appear to float above the paper. See if you can construct more complex three-dimensional pictures.

Focused Intelligences:
Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences

Additional Intelligences:
Interpersonal, Intrapersonal, Verbal/Linguistic and Naturalistic Intelligences
Dissection Worksheet: Cow’s Eye

A). Examine the surface of the eye and make 3 observations

1. ____________________________________
2. ____________________________________
3. ____________________________________

B. Identify:

1. Optic nerve
2. Blood vessels
3. Exterior muscles and tissue
4. Sclera
5. Cornea
6. Conjunctiva

C. Slowly slice back and forth across the top of the eye until you have broken through the surface. BE VERY GENTLE!!

D. List the three layers you sliced through.

1. __________________________
2. __________________________
3. __________________________

E. Separate the lens from the ciliary bodies. Make two observations about the lens.

1. _____________________________
2. _____________________________
F. Match the following structure of the cow eye with their function and/or description.

<table>
<thead>
<tr>
<th>tapetum</th>
<th>retina</th>
<th>ciliary body</th>
</tr>
</thead>
<tbody>
<tr>
<td>lucidum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lens</td>
<td>sclera</td>
<td>iris</td>
</tr>
</tbody>
</table>

1. ____________ Contains the photoreceptors for vision.
2. ____________ The coloured portion of the eye.
3. ____________ This structure changes shape to focus light on the retina.
4. ____________ The opening in the iris through which light passes.
5. ____________ The iridescent portion of the choroid layer found in nocturnal animals.
6. ____________ Consists of muscles, which control and shape the lens.
7. ____________ The white of the eye.
### Learning activities

<table>
<thead>
<tr>
<th>Learning activities</th>
<th>Intelligences focused in the learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cow Eye Dissection</strong></td>
<td><strong>Focused Intelligences:</strong></td>
</tr>
<tr>
<td>A cow eye is very similar to the eye of a human. By dissecting and examining the anatomy of a cow eye, we can learn how our own eye forms images of the world and sends these images to the brain.</td>
<td><em>Visual/Spatial, Bodily/Kinaesthetic</em> and <em>Intelligences</em></td>
</tr>
<tr>
<td><strong>Observation: External Anatomy</strong></td>
<td><strong>Additional Intelligences:</strong></td>
</tr>
<tr>
<td>If we feel around our eye, we can feel the bone of the skull. There’s fat surrounding the eyeball to keep it from bumping up against the bone and getting bruised.</td>
<td><em>Interpersonal, Intrapersonal,</em> and <em>Naturalistic Intelligences</em></td>
</tr>
</tbody>
</table>

Look carefully at the cow eye.

- The most noticeable part of the eye is the large mass of gray tissue that surrounds the posterior (back) of the eye and is attached to the sclera.
- The second most noticeable part of the eye is
the cornea, located in the anterior (front) part of the eye.

- On the posterior side of the eye, nestled in the fat and muscle tissue, there is a noticeably round protuberance that feels stiffer than the surrounding tissue. This is the optic nerve, and it sends the images collected in the eye to the brain.

Dissection: Internal Anatomy

Step:1

- Place the cow eye on a dissecting tray. The eye most likely has a thick covering of fat and muscle tissue.

- Carefully cut away the fat and the muscle. As we get closer to the actual eyeball, we can notice muscles that are attached directly to the sclera and along the optic nerve. These are the extrinsic muscles that allow a cow to move its eye up and down and from side to side.

- Keep cutting close to the sclera, separating the membrane that attaches the muscle to it. After removing the excess tissue, the sclera and optic nerve should be exposed but still intact.

- In the cow’s eye dissection, we cut away all the fat and muscle so that we can see the eyeball.

Focused Intelligences:
Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences

Additional Intelligences:
Interpersonal, Intrapersonal, and Naturalistic Intelligences
Step 2

- Now we are going to cut through the sclera and divide the eye in half, right around the middle. The cornea will be on the front half of the eye. The cornea is made of many layers of tissue.

- Using a sharp scalpel, cut through the sclera around the middle of the eye so that one half will have the anterior features of the eye (the cornea, lens, iris, and ciliary body)

- The other half will contain the posterior features (most noticeably where the optic nerve is attached to the eye).

- The inside of the eye cavity is filled with liquid. This is the vitreous humor. Depending on how the specimen was preserved, it will be either a dark liquid that will flow out easily, or a slightly gelatinous material that you can pour out to remove. (In a living eye, the vitreous humor is clear and gel-like.)

**Focused Intelligences:**
Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences

**Additional Intelligences:**
Interpersonal, Intrapersonal, and Naturalistic Intelligences
Step: 3

- Flip the anterior half of the eye over so that the front of it is facing upward.
- Using a pair of sharp scissors, cut the cornea from the eye along the boundary where the cornea meets the sclera.
- When the scissors have cut in far enough, a clear fluid will start to seep out - this is the aqueous humor, which is made of protein and water. The aqueous humor helps give the eye its shape. While cutting out the cornea, be careful to not accidentally cut the iris or the lens.

Focused Intelligences: Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences
- After removing the cornea, pick it up and look through it. Although it is cloudy due to the degrading of the tissue, it is still fairly transparent. Notice the toughness and strength of the cornea. It is designed this way to protect the more delicate features found inside the eye.

**Step 4**

- With the front of the anterior half of the eye facing up, locate the iris. Notice how the iris is positioned so that it surrounds and overlaps the lens.
- This position allows the iris to open and close around the lens to allow different amounts of light into the eye. In bright light, the iris contracts to let in less light. In dim light, such as at night, the iris expands to let in more light.
- If we look at our eye in a mirror, we can see a colored circle with a black spot in the middle. The colored circle is the iris.
- The black spot in the middle of the iris is the Additional Intelligences: Interpersonal, Intrapersonal, and Naturalistic Intelligences

**Focused Intelligences:**
- Visual/Spatial,
- Bodily/Kinaesthetic
- Mathematical/Logical Intelligences

**Additional Intelligences:**
- Interpersonal,
- Intrapersonal,
pupil, a hole through the iris that lets light into the eye. In dim light, the pupil opens wide, letting lots of light in.

**Step:5**

Flip the anterior half over and examine the back half. Locate the lens and ciliary body. The ciliary body surrounds the lens, allowing it to change the shape of the lens to help the eye focus on the object it is viewing.

**Focused Intelligences:**

*Visual/Spatial and Bodily/Kinaesthetic Intelligences*

**Additional Intelligences:**

*Interpersonal, Intrapersonal, and Naturalistic Intelligences*
**Step:6**

- After examining both sides of the anterior half of the eye, pull the lens out.

- While the cow was alive, the lens was clear and very flexible. In a preserved cow eye, the lens will most likely yellow and become very hard.

- However, it may still be possible to look through the lens and see its ability to magnify objects. Try this by placing the lens on a piece of paper with writing on it.

- Here, the lens works like a magnifying glass, making the words look bigger. The lens of the cow’s eye (like the lens of your eye) is shaped like the lens of a magnifying glass. It’s thicker in the middle than it is at the edges.

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**Focused Intelligences:**

Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences

**Additional Intelligences:**

Interpersonal, Intrapersonal, and Naturalistic Intelligences
Step:7

- On the posterior half of the eye, there is a thin, tissue-like material that slides easily inside the sclera. This is the retina.

- The retina contains photoreceptor cells that collect the light entering the eye through the lens from the outside world.

- These images are sent to the optic disc, the spot where the optic nerve attaches to the eye. At this point, there are no photoreceptor cells; there are only nerves sending images to the brain. Because of this, this place in the eye is often referred to as the blind spot since no images can be formed here.

- Here’s the back of the eye with the lens and vitreous humor removed. It’s shaped like a bowl. On the inside of the bowl is a thin film with red blood vessels running through it. The retina contains light-sensitive cells that detect light.
• The retina is attached to the back of the eye at just one spot. It’s called the blind spot. Because there are no light-sensitive cells at that spot, we can’t see anything that lands in that place on the retina.

• At the blind spot, all the nerves from the retina join to form the optic nerve.

• At the back of the eye, we can see the optic nerve, which carries messages from the retina to the brain.

• We see the world because the lens makes a picture on the retina, the retina sends a
message to the brain, and the brain turns that message into a mental picture of the world!

**Step:8**

- Most of the retina is not attached to the eye. Instead, it is held in place by fluids in the eye.
- The tissue of the retina gathers at the back of the eye where it forms into the optic nerve. This is the only place where the retina is attached to the eye.
- Use a pair of tweezers to gently lift the retina off the inside wall of the eye. The retina may tear because it is very delicate.
- Underneath the retina we can find a very shiny and colorful tissue. This is the choroid coat. The choroid coat is also known as the vascular tunic because it supplies the eye with blood and nutrients.
- In a human eye, the choroid coat is very darkly colored to minimize the reflection of light which would cause distorted images

**Step:9**

<table>
<thead>
<tr>
<th>Focused Intelligences:</th>
<th>Visual/Spatial, Bodily/Kinaesthetic and Mathematical/Logical Intelligences</th>
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<tr>
<td>Additional Intelligence:</td>
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**Focused Intelligences:**

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• Notice that the choroid coat in the cow's eye is very colorful and shiny. This reflective material is the tapetum lucidum.

• Its reflective properties allow a cow to see at night by reflecting the light that is absorbed through the retina back into the retina.

• While this does allow the cow to see better at night than humans can, it distorts the clarity of what the cow sees because the light is reflected so much.

• The tapetum lucidum is also responsible for the "glowing" eyes of animals, such as cats, when a small amount of light reflects off the tapetum lucidum in an otherwise dark room.

Here’s the inside of the back of the eye again.
Behind the retina is a layer of shiny, blue-green stuff called the tapetum. This layer assists night vision by reflecting light back through the retina. We don’t have a tapetum, but cats and cows (and other animals) do. A cat’s eyes shine in the headlights of a car because of the tapetum.
Lesson Plan No: 5

Lesson Title: Eye: Experiments

Lesson Objectives:

The pupil:

1. Framing questions that can be solved through experimentation.
2. Analyzing the characteristics of the experimental questions.
3. Verifying the testability of each question.
4. Analyzing the questions by using the criteria formulated.
5. Identifying dependable and independable variables.
6. Formulating hypothesis.
7. Creating operational definitions.
8. Evaluating the questions for its experiment ability by using specific criteria.
9. Creating procedures for experimenting the framed questions.
10. Observing and collecting data.
11. Analyzing the data for testing the hypothesis.
12. Creating inferences from the analyzed data.
13. Generalizing the inferences.
14. Creating conclusions

Intelligences Focused in Various Activities

- Mathematical/logical learners: activities - all activities
- Visual/spatial learners: activities - all activities
- Bodily/kinaesthetic learners: activities - all activities
- Interpersonal learners: activities - all activities
- Intrapersonal learners: activities - all activities
- Naturalist learners: activities - all activities
Activity 1

What kinds of questions do you have about the sense of sight that might be able to answer by experimenting? List all questions.

A good testable question:

- is simple
- can be answered through observations and measurements
- is practical to investigate in the classroom with readily available materials

Discuss in groups and find out which of the questions are testable, in other words, which are questions that can be answered through experimentation.

Sample questions

1. Why can't we see in the dark?

Clarify the meaning of the words "see" and "dark." Ask students how they might be able to measure their ability to see in the dark.

This question could be reframed as "How long does it take our eyes to adjust to dim light?"
Here students might set up an experiment to measure the rate of dark adaptation—how fast our eyes adjust so that we can see in dim light. Students might try sorting similar objects, first in bright light, next in very dim light, and finally in dim light after several minutes of letting their eyes adapt to the dim light.

2. How do we see colour?

This question can be reframed as "How well can we distinguish different colours under different light conditions?"

Students might set up experiments to test their ability to distinguish colours under different light conditions, such as bright sunlight, dim light, fluorescent light, incandescent light, black light, coloured-filter light, and so on.

Activity: 2

Simple experiments to demonstrate how our eyes work

Do these experiments with the partner, then write:

The procedure

What it showed about the eyes.

Then have a vision conference to compare results.

Materials needed: magnifying glasses and penlights, paper and pencil.

Focused Intelligences:

Mathematical/Logical

Visual/Spatial, and Bodily/kinaesthetic

Intelligences
**Automatic adjustment of the iris.**

**Procedure:** Put your hands tightly over your eyes for a few minutes. Then have your partner shine a penlight in your eyes the moment you remove your hands. What happens to the iris?

**Consolidation**

It closes, otherwise we would be blinded by excess light.

**Activity :3**

**Depth perception by the lens.**

**Procedure:** Hold your finger about 12 inches in front of your face. Focus on your finger and then focus on the background. Can you focus clearly on both at the same time?

**Consolidation**

No, because the lens must change its shape each time.

**Activity :4**

**How the lens focuses light on the retina.**

**Procedure:** You will need a magnifying glass and a white sheet of paper. Face the wall on the far side of the room from a window. Put the paper against the wall and bring the magnifying glass close enough to it to

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<tr>
<td>Interpersonal and Naturalistic</td>
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<td>Visual/Spatial, and Bodily/kinaesthetic</td>
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<th>Intelligences:</th>
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<tr>
<td>Bodily/</td>
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form the image of the window on the paper. Is the image right side up or upside down?

**Consolidation**

Upside down because the lens has turned it. The reason the whole world does not look upside down is because the brain rights the image for us.

**Activity :5**

**The rods and colour perception.**

**Procedure:** One student sits and stares straight ahead with both eyes. Her partner, who stands behind her, slowly brings a brightly coloured object around the side of the subject’s head until it can just be seen. What colour is it?

**Consolidation**

Can’t tell because the rods which see only black and white are the only cells on the periphery of the retina.

**Activity :6**

**The blind spot.**

**Procedure:** Draw two simple figures about three inches apart on a piece of paper. (for instance, a circle and a cross). Close one eye and focus on the circle as you bring the paper towards you. What happens?

**Consolidation**
• The cross will disappear as its image passes over the optic nerve exit where there are no rods or cones. This is called the blind spot.

• To compensate for this blind spot, the other eye often sees the images that the first eye cannot see and vice versa.

• In the rare occasions where neither eye can see a particular spot, the brain "fills in" the spot using the surrounding background information it receives from the eye. However, the "filling in" of the blind spot is not always accurate. To see this in action, try some blind spot experiments.

Activity 7

X-Ray Vision

Procedure: Roll up a piece of notebook paper into a tube. The diameter of the tube should be about 0.5 inch. Look through it with one eye. Look through the tube with your RIGHT eye AND keep your left eye open too. Place your open hand against the middle of the tube and look at it with the other eye. What do you see? What you should see is a hole in your left hand!! Why?

Consolidation

Your hand with a hole in it. Because your brain is getting two different images...one of the hole in the paper and one of your left hand. The brain is receiving

Focused Intelligences:

Mathematical/Logical
Visual/Spatial, and Bodily/kinaesthetic
Intelligences
two very different images and is putting them together as best it can. Seeing is a matter of the eyes and brain working together.

Activity :8

Optical Illusions

On hot summer days we can see pools of water shimmering on the highway ahead of us which always disappear as we approach.

Discuss and Find out the reason

Consolidation

These are of course mirages, caused by light bouncing off the hot air above the road.

In these illusions you eyes are sending the correct images to the brain, but the brain because of previous experiences becomes confused and gives us the wrong answers.

Activity :9

Shifting Backgrounds, Shifting Images

Procedure: Look at an object in the distance (20-30 feet away), such as a clock on the wall. Close one eye, hold up your arm and line up your finger with the object. Now without moving your finger or your head, close the opened eye and open the closed eye.
**Consolidation**

The object in the distance will appear to jump to the side...your finger will no longer be lined up. This shows that different images fall on each eye.

**Activity :10**

**Muller-Lyer Illusion**

Which of the lines shown below is longer?

![Image of Muller-Lyer Illusion]

**Consolidation**

Measure them. They are the same length. We see the lines as different because we have been "taught" to use specific shapes and angles to tell us about size.

**Activity :11**

**Do you see a vase or a face in the figure below?**

This type of picture was first illustrated by psychologist Edgar Rubin in 1915. Notice that it is very difficult to see both the faces and the vase at the same time.
Consolidation

This may happen because we tend to focus our attention on only one part of the image...either the faces or the vase.

Activity: 12

Afterimages.

Procedure: Can you put the fish in the bowl? Stare at the yellow stripe in the middle of the fish in the picture below for about 15-30 sec. Then move your gaze to the fish bowl. You should see a fish of a different colour in the bowl. It helps if you keep your head still and blink once or twice after you move your eyes to the bowl. The afterimage will last about five seconds.

Focused Intelligences:
Mathematical/Logical
Visual/Spatial, and Bodily/kinaesthetic
Intelligences
Activity :13

A test for red-green colour-blindness.

Procedure: People with normal colour vision should see an 8 on the left and a 5 on the right. People with red-green colour blindness may see 3 on the left 2 on the right. If you think that you are having trouble seeing colours correctly, have your colour vision checked by a doctor.

Activity :14

Subjective Contours:

Filling the gap. Your brain tries to fill in these four pictures with images that really are not there. Do you see a

Triangle?  

Cube?
Are these triangles real? They appear to be, because the brain automatically fills in lines that are missing. But if you block out parts of the picture, the white triangle vanishes.

**Activity :15**

**Baldwin Effect:**

The distance between the two large boxes is the same as the distance between the two small boxes. For many people, the distance between the small boxes appears larger.

**Focused Intelligences:**

*Mathematical/Logical*

*Visual/Spatial, and Bodily/kinaesthetic*

**Intelligences**
**Activity :16**

Is this book opening toward you or away from you?

<table>
<thead>
<tr>
<th>Focused Intelligences:</th>
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<tbody>
<tr>
<td><strong>Mathematical/Logical</strong></td>
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<tr>
<td><strong>Visual/Spatial, and Bodily/kinaesthetic</strong></td>
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<tr>
<td><strong>Intelligences</strong></td>
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</table>
Lesson Plan No: 6

Lesson Title: Disorders of the Eye

Lesson Objectives:

The pupil:

1. Identifying the common eye diseases.
2. Classifying the common eye diseases by creating suitable criteria.
3. Identifying the parts of the eyes affected by each eye diseases.
4. Comparing the normal eye with the diseased eye.
5. Analysing the images formed by the various diseased eyes.
6. Analysing the symptoms of each eye disease.
7. Discussing the possible treatments.
8. Analysing preventive measures for each eye disease.

Intelligences Focused in Various Activities

- Verbal/linguistic learners: activities - all activities
- Mathematical/logical learners: activities - all activities
- Visual/spatial learners: activities - all activities
- Bodily/kinaesthetic learners: activities - 12
- Interpersonal learners: activities - 1,2,3,4,5,9,11,12,14,15,16,17
- Intrapersonal learners: activities - 1,6,7,8,10,11,13,14,15,16,17,18
- Naturalist learners: activities - all activities
<table>
<thead>
<tr>
<th>Learning activities</th>
<th>Focused Intelligences:</th>
</tr>
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<tbody>
<tr>
<td><strong>Activity:1</strong></td>
<td><strong>Intelligences</strong></td>
</tr>
<tr>
<td>1. Discuss and find out different eye diseases and eye defects</td>
<td><strong>Naturalistic and Mathematical/Logical Intelligences</strong></td>
</tr>
<tr>
<td>2. Classify them according to your criteria</td>
<td></td>
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<tr>
<td><strong>Teacher Consolidates: Eye Diseases</strong></td>
<td>Additional Intelligence:</td>
</tr>
<tr>
<td>Common eye problems include:</td>
<td><strong>Interpersonal and Intrapersonal Intelligences</strong></td>
</tr>
<tr>
<td><strong>Cataracts</strong> - clouded lenses</td>
<td></td>
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<tr>
<td><strong>Glaucoma</strong> - damage to the optic nerve from too much pressure in the eye</td>
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<tr>
<td><strong>Retinal disorders</strong> - problems with the nerve layer at the back of the eye</td>
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<tr>
<td><strong>Conjunctivitis</strong> - an infection also known as pinkeye</td>
<td></td>
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<tr>
<td>Other <strong>eye disorders, eye injuries</strong> and <strong>birth defects</strong> can also cause vision loss.</td>
<td></td>
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<tr>
<td>There are many other causes of blindness, such as <strong>vitamin A deficiency, tumors, strokes, neurological diseases, other infections, hereditary diseases and toxins</strong></td>
<td></td>
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<tr>
<td><strong>Refractive Errors</strong></td>
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<tr>
<td>Four common refractive errors are:</td>
<td></td>
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<tr>
<td><strong>Myopia, or nearsightedness</strong> - clear vision close up but blurry in the distance</td>
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</table>
Hyperopia, or farsightedness - clear vision in the distance but blurry close up

Presbyopia - inability to focus close up as a result of aging

Astigmatism - focus problems caused by the cornea

Glasses or contact lenses can usually correct refractive errors. Laser eye surgery may also be a possibility.

Activity: 2

Closely observe the diagrams given below and find out:

What is a cataract?

Identify the part of the eye that is affected.

Eye without a cataract | Eye with a cataract

Teacher Consolidates: Lens is the affected part

Activity: 3

Compare the two eyes in the diagram and find out:

1. The differences in the nature of the lens
2. What is the reason for this change?
3. How does this change affect the process of vision?

Teacher Consolidates

**Cataracts**

- The lens focuses light on the retina. In the normal eye, light passes through a clear lens to produce clear, sharp images.

- A cataract is a clouding of the natural lens. The lens is contained in a sealed bag or capsule. As old cells die they become trapped within the capsule. Over time, the cells accumulate causing the lens to cloud, making images look blurred. Normally, cataracts are a natural result of aging.

- This clouding distorts rays of light and prevents light from being focused on the retina. This results in distortion of in one's vision.

- "Cataract" comes from the Latin word *cataracta* meaning "waterfall." Looking through a waterfall is similar to the vision that results from cataracts.

Mathematical/Logical Intelligences

Additional Intelligences:

Interpersonal and Naturalistic Intelligences
Activity: 4

Analyze the images formed by the normal and cataract eye and find out the Symptoms.

Normal Vision

Teacher Consolidates: Symptoms

Cataracts may cause:

- Blurred vision

Focused Intelligences:
Visual/Spatial and
Mathematical/Logical Intelligences

Additional Intelligences:
Interpersonal and Naturalistic Intelligences
- Double vision
- Poor night vision
- Need for bright lights when reading

**Activity: 5**

Discuss and find out the risk factors of cataract possible treatments.

**Teacher Consolidates: Risk Factors**

Age, Ultraviolet Radiation, Cigarette Smoking and Eye Injuries can cause cataracts.

**Treatment**

Surgery: a cataract is removed and a new lens is inserted into the eye.

**Activity: 6**

Compare the two eyes in the diagram and find out:

1. Part of the eye that is affected.
2. What is diabetes?
3. How does this occur?
4. How does this change affect the process of vision?

![Diagram of Normal Eye vs. Eye with Diabetic Neuropathy](image)

**Focused Intelligences:**

Visual/Spatial and Mathematical/Logical Intelligences

**Additional Intelligences:**

Interpersonal and Naturalistic Intelligences

**Focused Intelligences:**

Visual/Spatial and Logical Intelligences

**Additional Intelligences used:**

Intrapersonal and Naturalistic Intelligences
Teacher Consolidates: Diabetic Retinopathy

- In people with diabetes, high blood sugar levels affect many tissues in the body including the skin, heart, kidneys, nervous system, feet, teeth, gums and eyes.

- Diabetic retinopathy refers to damage to the blood vessels of the retina caused by diabetes. These blood vessels bring oxygen and nutrients to the retina.

- When the blood vessels are become damaged, they weaken and sometimes break, leaking fluid into the retina and causing the retina may to swell.

- As new blood vessels grow on the retina, blurred vision or temporary blindness can result. Scare tissue can form and cause blindness where old blood vessels were attached to the retina.

Activity: 7

Identify the progressive changes in the diabetic retinopathy. How does diabetes affect the retina?
• The earliest phase is known as **background diabetic retinopathy** where, the arteries in the retina become weakened and leak, forming small, dot-like hemorrhages. These leaking vessels often lead to swelling or edema in the retina and decreased vision.

• The next stage is the **proliferative diabetic retinopathy**. In this stage, circulation problems cause areas of the retina to become oxygen-deprived. New, fragile, vessels develop. This is called neovascularization. These delicate vessels hemorrage easily. Blood may leak into the retina causing spots, along with decreased vision.

• In the later phases of the disease, continued abnormal vessel growth and scar tissue may cause serious problems such as retinal detachment and glaucoma.

**Activity: 8**

Analyze the images formed by the normal and Diabetic retinopathy and find out the symptoms of the eye defect.
Teacher Consolidates: Signs and Symptoms

The affect of diabetic retinopathy on vision varies widely, depending on the stage of the disease. Some common symptoms are listed below; however, diabetes may cause other eye symptoms.

Blurred vision; Floaters and flashes; Sudden loss of vision.

Activity: 9

Discuss and find out the risk factors of diabetic retinopathy, possible treatments and preventive measures.

Teacher Consolidates: Risk Factors

Diabetes, Kidney Disease, High Blood Pressure, High Blood Fat, Obesity and Pregnancy.

Diagnosis: Eye examination: an eye doctor will look for a swollen retina, leaking blood vessels, optic nerve damage, and retinal detachments.

Treatment

Photocoagulation: a laser is used to stop bleeding of retinal blood vessels.

Vitrectomy: the vitreous and scar tissue is removed and then replaced with clear fluid.

Activity: 10

1. Analyze the retinal layer of the eye and find out the significance of the Macula and Fovea.
Teacher Consolidates

The macula is located in the centre of the retina and provides information for fine, detailed vision when we look straight ahead.

The fovea is the very centre of the macula. The macula allows us to appreciate detail and perform tasks that require central vision such as reading.

Activity:11

Read the article given below and find out the major symptoms of Age-related Macular Degeneration

**Age-related Macular Degeneration (AMD)**

This is a disease associated with aging that gradually destroys sharp, central vision. Central vision is needed for seeing objects clearly and for common daily tasks such as reading and driving. AMD causes no pain.

In some cases, AMD advances so slowly that people notice little change in their vision. In others, the disease
progresses faster and may lead to a loss of vision in both eyes.

There are two types of AMD, classified as "wet" and "dry." The most common form is the dry type.

Wet AMD occurs when blood vessels growing up from beneath the retina leak blood. Leaked blood pushes on the light receptor cells resulting in damage to the retina.

This example demonstrates what a patient with advanced macular degeneration sees.

**Teacher Consolidates**

- AMD is caused by hardening of the arteries that nourish the retina. As a result, the central vision deteriorates.

- Macular degeneration varies widely in severity. In the worst cases, it causes a complete loss of central vision, making reading or driving impossible. For others, it may only cause slight
distortion.

- Fortunately, macular degeneration does not cause total blindness since it does not affect the peripheral vision.

**What is the difference between wet and dry macular degeneration?**

AMD is classified as either wet (**neo-vascular**) or dry (non-neo-vascular). About 10% of patients who suffer from macular degeneration have *wet AMD*. This type occurs when new vessels form to improve the blood supply to oxygen-deprived retinal tissue. However, the new vessels are very delicate and break easily, causing bleeding and damage to surrounding tissue.

![Dry and Wet Macular Degeneration](image)

**Dry macular degeneration**: although more common, typically results in a less severe, more gradual loss of vision. The dry type is characterized by drusen and loss of pigment in the retina. Drusen are small, yellowish deposits that form within the layers of the retina.

**Nutrition and macular degeneration**

Several recent studies have indicated a strong link between nutrition and the development of macular...
degeneration. It has been scientifically demonstrated that people with diets high in fruits and vegetables (especially leafy green vegetables) have a lower incidence of macular degeneration. More studies are needed to determine if nutritional supplements can prevent progression in patients with existing disease.

**Risk Factors**

*Gender*: women may be at greater risk than men.

*Smoking*: smoking may increase the risk of AMD.

*Family History*: AMD may run in families.

*Cholesterol*: people with high levels of blood cholesterol may be at higher risk for AMD.

**Diagnosis**

*Eye examination*: an eye doctor will look for problems with the macula.

*Fluorescein angiography*: an intravenous dye is injected into a patient. Photographs are taken as the dye passes through retinal blood vessels.

**Treatment**

Photocoagulation: a laser is used to destroy abnormal blood vessels that develop in the macula.

**Activity: 12**

Analyze the diagram below and find out:

- The position of Aqueous Chamber

**Focused Intelligences:**

Mathematical/
- The fluid filled in the cavity
- Functions of the fluid in the eye
- Cite of fluid formation
- Cite of exit of the fluid

Draw a flow diagram of the Circulation of Aqueous Humor in the eye

Circulation of Aqueous Humor

Teacher Consolidates: Glaucoma

- Glaucoma refers to a group of disorders that all cause increased pressure within the eyeball *intraocular pressure* (IOP). In a normal eye, a liquid called the *aqueous humor* is continuously produced and drained.

- In glaucoma, aqueous humor builds up and increases pressure within the eye. Such increased pressure can damage the optic nerve directly or restrict blood flow, thus damaging the optic nerve indirectly.

- This damage may lead to blind spots in the...
visual field. If left untreated, glaucoma can cause permanent blindness.

- Most people’s IOPs fall between 8 and 21. However, some eyes can tolerate higher pressures than others. That’s why it may be normal for one person to have a higher pressure than another.

**Activity: 13**

From the diagram given below find out the symptoms of Glaucoma.

**Teacher Consolidates: Symptoms**

- Loss of peripheral vision
- Sensitivity to light and glare
- Problems with night vision
- Blurred vision

**Risk Factors**

Age, Family History, Diabetes, Corticosteroid use:

**Diagnosis**

*Tonometry:* eyeball pressure is measured. Abnormally
high eyeball pressure may suggest glaucoma.

**Optic Nerve Examination:** an eye doctor will examine the retina and check for damage.

**Visual Field Examination:** a patient's visual field (area in front) will be mapped to check for visual loss.

**Tonometer**

**Treatment**

There is no cure for glaucoma and if the optic nerve is damaged, it cannot be fixed. The effects and progression of glaucoma can be controlled, however, by lowering the pressure within the eye.

- Drugs that reduce the production of aqueous humor:
- Drugs that increase the outflow of aqueous humor:
- Surgery to improve the outflow of aqueous humor.
- Implantation of a device to drain fluid in the eye.

Normal eye pressure ranges from 10-22 mm Hg
## Activity: 14

Discuss and find out:

- Identify Conjunctiva in the diagram
- What is the function of the Conjunctiva in our eye
- Describe the symptoms of the pinkeye.
- Identify the causes

---

**Teacher consolidates**

**Pinkeye: Conjunctivitis**

Conjunctivitis is the medical name for pinkeye. It can cause swelling, itching, burning, discharge and redness of the protective membrane that lines the eyelids and covers exposed areas of the white of the eye.

**Causes include**

- Bacterial or viral infection
- Allergies

---

**Focused Intelligences:**
- Visual/Spatial
- Mathematical/Logical

**Additional Intelligence:**
- Intrapersonal
- Interpersonal, and naturalistic

---

**the conjunctiva only includes this membrane behind your lids**

---
Substances that cause irritation

Contact lens products, eye drops, or eye ointments

Pinkeye usually does not affect vision. Infectious pink eye can easily spread from one person to another. The infection will clear in most cases without medical care, but bacterial pinkeye needs treatment with antibiotic eye drops or ointment.

Activity: 15

Have you ever seen this "eye chart" before? It is smaller than the real version of the chart that is used to test how well you can see. It was first developed in 1863.

Discuss and find out:

What is the purpose of this "eye chart"?

What is meant by 20/20 vision?

Teacher Consolidates

*Do You Wear Glasses? Here's Why!*

If you have 20/20 vision, it means that at a distance of 20 feet, you can read a certain line (labelled 20) on the
chart and that your vision is normal.

If you can only see the top line clearly (the one labelled 200), then you have 20/200 vision. This means that you must be 20 feet from the chart to see what most people can see at 200 feet. By the way, if someone's vision is 20/200 or worse, then they are legally blind. Legal blindness is usually defined as visual acuity **less than 20/200** with corrective lenses.

**Activity: 16**

Observe the diagram and find out:

1. The nature of the image on the retina.
2. The nature of the image behind the retina.
3. Which is more sharp and clear?
4. What is the reason?

**Teacher Consolidates: Long sight (Hypermetropia)**

**Focused Intelligences:**

*Visual/Spatial* and *Mathematical/Logical Intelligences*

**Additional Intelligence:**

*Intrapersonal, Interpersonal,* and *naturalistic Intelligences*
• Someone with long sight can see distant objects clearly but cannot focus properly on near objects.

• This is because the lens focuses the sharpest image behind the retina instead of on it.

• This defect is often age-related, and due to a loss of elasticity in the lens. It is corrected by putting a convex lens in front of the eye.

Activity: 17

Observe the diagram and find out:

1. The nature of the image on the retina.

2. The nature of the image behind the retina.

3. Which is more sharp and clear?

4. What is the reason?

Teacher Consolidates: Short sight (Myopia):

Someone with short sight can see near objects clearly
but cannot focus properly on distant objects.

This is because the lens focuses the sharpest image in front of the retina instead of on it. It is usually an inherited defect, caused by the eyeball being elongated, so that the distance between the lens and the retina is too great.

It can be corrected by placing a concave lens in front of the eye.

Teacher consolidated by using animated diagrams with appropriate changes in the rhythm.
Activity: 18

Identify the diseases

- Normal Vision
- Cataract
- Age-related Macular Degeneration
- Glaucoma
ACHIEVEMENT TEST IN BIOLOGY- PART 1

(Draft Form)

Standard X                                                                                    Max Time: 60 min
                                                          Max Scores: 60

General instructions

(Fill in your name, class, division and school on the answer sheet provided. Attempt all questions. Each question carries 1 score. On your answer sheet write the letter that matches your answer.)

1. The bulging white of the eye is
   A. choroid
   B. conjunctiva
   C. retina
   D. cornea
   E. iris

2. What regulates the amount of light entering the eye
   A. cornea
   B. iris
   C. retina
   D. sclera
   E. ciliary body

3. Which of the following nourishes the retina, through its blood supply
   A. choroid
   B. iris
   C. cornea
   D. retina
4. What provides a surface for image formation
   A. choroid
   B. iris
   C. retina
   D. cornea

5. A loss of transparency of the lens is called
   A. presbyopia
   B. astigmatism
   C. cataract
   D. none of the above

6. In which of the following disorders of the eye, there is complete distortion of vision
   A. detachment of retina
   B. presbyopia
   C. astigmatism
   D. none of the above

7. ----- carry impulses from the sensory cells (rod and cones) to the brain for interpretation
   A. optic nerve fibres
   B. retina
   C. ciliary body
   D. cornea

8. When a person reads through a page, only a few words can be seen clearly each time. This is because
   A. most of the words cannot be focused onto the retina.
   B. only a few words can be focused onto the yellow spot.
   C. some words are focused onto the blind spot.
   D. the brain can only interpret a few words each time.
9. The amount of light entering the eye is determined by the size of the
   A. retina
   B. pupil
   C. cornea
   D. fovea

10. Which of the following describes the relationships between different structures of the eyeball?

<table>
<thead>
<tr>
<th></th>
<th>Ciliary muscles</th>
<th>Suspensory ligament</th>
<th>Lens</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>contracted</td>
<td>tension increased</td>
<td>thick</td>
</tr>
<tr>
<td>B.</td>
<td>contracted</td>
<td>tension decreased</td>
<td>thin</td>
</tr>
<tr>
<td>C.</td>
<td>relaxed</td>
<td>tension decreased</td>
<td>thick</td>
</tr>
<tr>
<td>D.</td>
<td>relaxed</td>
<td>tension increased</td>
<td>thin</td>
</tr>
</tbody>
</table>

Answer the questions 11 to 13 based on the diagram of the section of the human eye given below.
11. Which structure contains muscle that helps in accommodation?

A. 1  
B. 2  
C. 7  
D. 6

12. When a person tries to focus on a distant object, which of the following changes occurs?

<table>
<thead>
<tr>
<th>Structure 2</th>
<th>Structure 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>contracts</td>
<td>more convex</td>
</tr>
<tr>
<td>contracts</td>
<td>less convex</td>
</tr>
<tr>
<td>stretched</td>
<td>more convex</td>
</tr>
<tr>
<td>stretched</td>
<td>less convex</td>
</tr>
</tbody>
</table>

13. The shape of the eyeball is maintained by

A. 3 and 5  
B. 3 and 6  
C. 1 and 5  
D. 1 and 6

14. The drawing below shows a light ray diagram of a defective human eye, and two types of lens for correcting certain eye defects. What is this eye defect and how may it be corrected?
<table>
<thead>
<tr>
<th></th>
<th>Eye defect</th>
<th>Lens to be used for correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>long sight</td>
<td>lens I</td>
</tr>
<tr>
<td>B.</td>
<td>long sight</td>
<td>lens II</td>
</tr>
<tr>
<td>C.</td>
<td>short sight</td>
<td>lens I</td>
</tr>
<tr>
<td>D.</td>
<td>short sight</td>
<td>lens II</td>
</tr>
</tbody>
</table>

Directions: Question 15 refers to the diagram below which shows the path of light rays reaching a defective eye through a corrective lens:

15. What is the cause of this eye defect?
   A. The eyeball is too long.
   B. The cornea is not smooth.
   C. The lens of the eyeball is too thin.
   D. The lens is of the eyeball is not elastic.

16. Nerve impulses are carried from the eye to the brain by the

   A. optic nerve
   B. cornea
   C. bipolar cells
   D. rod and cone cells
   E. vestibular apparatus
17. A child was watching a bee which was flying away from him and landing on a flower. Which of the following graphs shows the change in the curvature of the lens of his eye?

18. Rod cells and cone cells are located in the

   A. organ of Corti  
   B. retina  
   C. iris  
   D. cornea  
   E. pupil

19. Which of the following help(s) to determine the sharpness of an image on the retina?

   A. optical power of the cornea  
   B. optical power of the lens,  
   C. length of the eyeball  
   D. all of the above

20. The optic disk is a “blind spot” in the visual field because:

   A. the virtual absence of large blood vessels here  
   B. the relative thinning of the retina here  
   C. the absence of photoreceptors here  
   D. the absence of nerve axons here
21. What structures does light pass through before reaching the primary visual cortex? (list in order)
   A. cornea, vitreous humor, retinal ganglion cells, rods and cones
   B. vitreous humor, lens, aqueous humor, retinal ganglion cells
   C. lens, vitreous humor, rods and cones, retinal ganglion cells
   D. cornea, aqueous humor, sclera, retinal ganglion cells

22. The diagram below was drawn by a student to show the path of light rays when a short-sighted person was looking at a distant object: What is wrong with this diagram?

![Diagram of light rays]

A. The rays should be focused on the retina.
B. The rays should be focused behind the retina.
C. The rays from the object should be diverging.
D. The object should not be drawn.

23. Which of the following is sensitive to the colour wavelengths of light

A. rods
B. cones
C. ganglion cells
D. horizontal cell
24. The fovea is part of the
A. cornea
B. iris
C. papillae
D. retina
E. organ of Corti

25. Which of the following statements is correct?

A. In order to produce a clear image, the aqueous humor is involved in the process of accommodation.
B. The space anterior to the lens is filled with the vitreous humor.
C. The function of the crystalline lens is to bend light rays and focus them on the retina.
D. The amount of light entering your eye is regulated by smooth muscle in the ciliary body.
E. Nearsightedness is a condition resulting from loss of lens elasticity

26. The inner surface of the eyelids is lined with _____________.

A. conjunctiva
B. extrinsic eye muscles
C. dense connective tissue
D. lacrimal apparatus

27. The region on the retina that produces the sharpest vision is called the _____________.

A. sclera
B. aqueous humor
C. fovea centralis
D. optic disk
Directions: Questions 28 and 29 refer to the graph below which shows the changes of the lens thickness of a boy's eye within 10 seconds:

28. What changes occur in the boy's eye between the 2nd and 4th seconds?
   A. The pupil is dilating.
   B. The ciliary muscles are relaxing.
   C. The suspensory ligaments are contracting.
   D. The tension on the suspensory ligaments is decreasing.

29. Between the 6th and the 8th second, the boy is looking at
   A. a far away stationary object.
   B. a nearby stationary object.
   C. an object is moving towards him.
   D. an object is moving away from him.

30. Which of the following statements about short sight is / are true?
   (1) The eyeball is too long.
   (2) Distant objects are focused in front of the retina.
   (3) A convex lens is used for its correction.
   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)
31. The _____ is a membrane covering the anterior portion of the eyeball
   A. cornea
   B. conjunctiva
   C. sclera
   D. eyelid

32. Which of these is the last in the tear flow sequence?
   A. lacrimal duct
   B. nasolacrimal duct
   C. lacrimal gland
   D. lacrimal sac

33. __________, or opaque lenses, can make a person functionally blind despite having healthy photoreceptors and visual pathways
   A. macular degeneration
   B. cataracts
   C. phacoemulsification
   D. glaucoma

34. What is trachoma?
   A. increased intraocular pressure that can lead to diminished vision
   B. a separation of the outer pigmented and inner neural layers of the retina
   C. a chronic, contagious form of "pink eye" that can cause blindness
   D. inflammation of the conjunctiva in response to airborne irritants

35. The photoreceptors that perceive colour and sharp vision are
   A. amacrine cells.
   B. rods.
   C. horizontal cells.
   D. cones.
36. Label the parts of the eye on the diagram. (4 points)

37. Aqueous humor:

A. provides nutrients for the retina  
B. is produced from capillaries in the iris  
C. can cause cataracts if overproduced  
D. is present in the anterior and posterior chambers  
E. all of the above

38. A person with an abnormally short eyeball (anterior to posterior) would be ----- and would wear ----- lenses to correct their vision.

A. nearsighted / concave  
B. farsighted /concave  
C. nearsighted / convex  
D. farsighted /convex

39. Vision is most acute when light rays are brought to focus on the

A. fovea centralis  
B. the outermost layer of the retina  
C. optic disc  
D. cells in the occipital lobes of the brain  
E. none of the preceding.
40. Night blindness can be treated with:

A. vitamin C  
B. vitamin D  
C. vitamin K  
D. none of the preceding.

41. Squirrels don’t come out at night because they can’t see in the dark.

A. Squirrels only have one type of rod photoreceptor  
B. Squirrels don’t have rods  
C. Squirrels only have one type of cone photoreceptor  
D. Squirrels don’t have cones

42. Why do we move our hands while walking?

A. To relieve our tension  
B. To walk faster  
C. To maintain equilibrium against force of gravity  
D. To increase blood circulation and oxygen supply
43. Construct a flow chart that shows what happens inside the black box of hearing by arranging the names given below in the correct order.

A. Tympanic membrane (eardrum)  
B. Ossicles  
C. Pinna (outer ear)  
D. Cochlea  
E. Brain,  
F. Auditory nerve,  
G. Organ of Corti,  
H. Auditory canal  
I. Oval window

44. Trace the path of light through the eye to the retina, and on to the primary visual cortex? (List in order)

A. cornea  
B. rods and cones,  
C. retinal ganglion cells  
D. lens  
E. aqueous humor,  
F. vitreous humor  
G. conjunctiva

45. Which set includes only general senses?

A. Temperature, pain, touch, stretch, and pressure  
B. Pain, pressure, balance, taste, and smell  
C. Vision, hearing, balance, smell, and taste  
D. Equilibrium, vibration, hearing, touch, and vision
46. If you place a drop of honey or a sugar cube into your mouth, which food will stimulate the sweet taste buds first?

   A. Sugar cube  
   B. Honey  
   C. There is no difference

47. Name the animal which has compound eyes
   
   A. Squirrel  
   B. Fish  
   C. Crow  
   D. Honey bee

48. The basilar membrane
   
   A. is wider at the base end than at the apex  
   B. is stiffer at the apex than the base  
   C. responds to low frequencies at the apex  
   D. is inflexible

49. In the vestibular system, otolith detect ______ and semicircular canals are sensitive to _____
   
   A. head rotation to the left / head rotation to the right  
   B. head rotation to the left / tilts of the head  
   C. head rotations / force of gravity  
   D. force of gravity / rotations of the head

50. If a human being had no anvil and stirrup, he would probably be unable to:
   
   A. see  
   B. taste  
   C. smell  
   D. hear  
   E. think
51. Squirrels don’t come out at night because they can’t see in the dark.

A. Squirrels only have one type of rod photoreceptor
B. Squirrels don’t have rods
C. Squirrels only have one type of cone photoreceptor
D. Squirrels don’t have cones

52. The macula is part of the

A. cornea
B. iris
C. papillae
D. retina
E. organ of Corti

**Match the following**

Items A to E may be used more than once.

( A. Presbyopia       B. cataract  C. glaucoma      D. myopia    E. hyperopia.)

53. Clouding of the lens.
54. Elongation of the eyeball.
55. Loss of elasticity of the lens with aging.
56. Compression of, and loss of fibers in the optic nerve.
57. Associated with an increase in intraocular pressure.
58. Eyeball is too short.
59. The lens tends to lose its ability to accommodate.
60. Often referred to as nearsightedness
Appendix I

ACHIEVEMENT TEST IN BIOLOGY- PART 2

(Draft Form)

Standard X Max Time: 60 min
Max Scores: 60

General instructions

(Fill in your name, class, division and school on the answer sheet provided. Attempt all questions. Each question carries one score. On your answer sheet write the letter that matches your answer.)

1. Coiled structure located in the inner ear is known as _______.
   A. Helico trema
   B. Eustachian tube
   C. Cochlea
   D. Semicircular canal

2. Which part of the internal ear is meant for hearing?
   A. Ear Drum
   B. Cochlea
   C. Auditory Bones
   D. All of these

3. Small elevations on the tongue which contain taste buds are known as
   A. Receptors
   B. Papillae
   C. Humps
   D. Gyri
4. Smallest bone in the human body.
   A. Hyoid
   B. Incus
   C. None of these
   D. Stapes

5. The end organs (receptors) of taste sensation are called _______.
   A. Tongue
   B. Papillae
   C. Taste buds
   D. Taste pores

6. After a car accident, a man had problem in balancing himself during walking. However, he could still hear well. What body structures might have been damaged?
   (1) Cerebrum
   (2) cerebellum
   (3) cochlea
   (4) semicircular canals
   A. (1) and (3) only
   B. (1) and (4) only
   C. (2) and (3) only
   D. (2) and (4) only

7. _______ membrane is found between external and middle ear.
   A. Ear
   B. Tympanic
   C. Auditory
   D. Vestibular
8. ______ apparatus is a part of the internal ear and is responsible for maintenance of equilibrium and posture.

A. Vestibular
B. Tympanic
C. Cochlea
D. Ear Drum

9. Identify the ear ossicle "A" & “B” in this diagram

Directions: Questions and 10-11 refer to the diagram below which shows the structure of a human ear

10. Many people suffer sea-sickness when travelling on boats. This sickness is caused by over-stimulation of
11. Which of the following are functions of structure 2?
   (1) To amplify vibrations
   (2) to transmit vibrations
   (3) to equalize the pressure on both sides of structure 1

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

12. After the inner ear has perceived sound, the sound is dissipated because ______
   A. perilymph inside the scala tympani absorbs the sound wave energy
   B. endolymph inside the cochlear duct absorbs sound wave energy
   C. air inside the middle ear dissipates the sound waves
   D. perilymph inside the scala vestibuli absorbs sound wave energy

Directions: Questions 13 and 14 refer to the diagram below which shows the structure of the ear:
13. Sensory hair cells are located in
   A. 1 and 3
   B. 1 and 4
   C. 2 and 3
   D. 2 and 4

14. Which regions are filled with air?
   A. 2 and 4
   B. 4 and 5
   C. 5 and 6
   D. 6 and 7

15. "Tuning out" background sounds while you study is possible because of a sensory phenomenon called
   A. paraconsciousness
   B. selective receptivity
   C. concentration
   D. adaptation

16. The diagram below shows a section of a certain part of the human ear. The receptor will be stimulated when

   A. the head turns.
   B. the eardrum vibrates.
   C. the perilymph moves.
   D. the atmospheric pressure changes.
17. Which of the following occurs when a person is going up in a lift from ground floor to 20th floor?

<table>
<thead>
<tr>
<th>Change in atmospheric pressure</th>
<th>Movement of eardrum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. increase</td>
<td>bulge inwards</td>
</tr>
<tr>
<td>B. increase</td>
<td>bulge outwards</td>
</tr>
<tr>
<td>C. decrease</td>
<td>bulge inwards</td>
</tr>
<tr>
<td>D. decrease</td>
<td>bulge outwards</td>
</tr>
</tbody>
</table>

18. Which of the following is a correct matching between a stimulus and the location of its receptors?

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Location of receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. light</td>
<td>cornea</td>
</tr>
<tr>
<td>B. body movement</td>
<td>cochlea.</td>
</tr>
<tr>
<td>C. taste of honey</td>
<td>Semicircular canals</td>
</tr>
<tr>
<td>D. Hearing music</td>
<td>lips</td>
</tr>
<tr>
<td>E. scent of flower</td>
<td>nasal cavity</td>
</tr>
</tbody>
</table>

19. Which is the last structure to vibrate in this sequence?

A. malleus
B. oval window
C. stapes
D. incus

20. Which statement is true about the cochlear duct?

A. It is part of the bony labyrinth.
B. It is filled with perilymph.
C. It contains hair cells that convert sound waves into nerve impulses.
D. It contains a spiral organ that rests on a vestibular membrane
21. The portion(s) of the tongue that actually perceives taste is/are the
   A. taste hairs
   B. papillae
   C. epithelium of tongue
   D. taste buds

Directions: Question 22 and 23 refer to the diagram below which shows part of the ear of a person:

22. The function of structure 2 is
   A. to maintain body balance.
   B. to control muscular movement.
   C. to detect head movement.
   D. to detect body position.

23. Structure 3 is very long so as to
   A. to amplify sound vibrations.
   B. to detect different frequencies of sound vibrations.
   C. to increase its sensitivity to sound vibrations.
   D. to distinguish between sounds of different loudness

24. The two sac-like structures of the inner ear called the utricle and saccule

   A. contain a fluid called perilymph
   B. are part of the membranous labyrinth within the vestibule
   C. form the connection between the semicircular canals and the vestibule
   D. function as part of the auditory system
   E. answers A and C
25. Middle ear infection may follow a throat infection because:

A. the eustachian tube opens into the base of the inner ear
B. the pharyngeal mucosa is continuous with the mucosa of the middle ear
C. the sphenoid sinus opens into the tympanic cavity of the middle ear
D. the vestibulocochlear nerve passes through the tympanic cavity
E. answers A and D.

26. In the physiology of hearing, which action is it that generates an action potential that causes release of a neurotransmitter substance?

A. movement of cells in the basilar membrane against the spiral organ
B. pressure waves on cells of the vestibular membrane
C. movement of the spiral organ hair cells against the tectorial membrane
D. movement of the membrane covering the round window

27. A person who lacked otoliths would probably have trouble

A. seeing.
B. hearing.
C. sensing her body’s movement.
D. sensing her body’s orientation.
E. understanding this question.

28. The sensory neurons of the auditory system respond

A. directly to pressure changes in the air.
B. directly to pressure changes in the cochlear fluid.
C. to mechanical disturbances of the organ of Corti.
D. to chemical stimulation of the organ of Corti.
E. to fluid movements in the semicircular canals.
29. When a drop of sucrose solution was put onto the sides of a girl's tongue, it did not taste sweet to her. A possible conclusion is that
   A. the girl's tongue is not sensitive to sucrose solution.
   B. sucrose solution is not as sweet as glucose solution.
   C. no sensory cells for sweet taste are present on the sides of the girl's tongue.
   D. sensory cells for sweet taste are only present at the tip of the girl's tongue.

30. A sensory receptor capable of detecting changes in hydrogen ion concentration is more accurately described as a
   A. thermoreceptor
   B. pain receptor
   C. mechanoreceptor
   D. chemoreceptor

31. ----- is the interpretation centre for sensory impulses
   A. thalamus
   B. pons
   C. mid brain
   D. hypothalamus

32. Which of the following is not true concerning the olfactory system of mammals?
   A. Olfactory receptors are restricted to the nasal cavity.
   B. The “cilia” of olfactory neurons are not true cilia.
   C. The olfactory cilia are covered in a layer of mucus.
   D. Stimulation of olfactory neurons involves the G-protein system.
   E. Each olfactory neuron is sensitive to only one chemical.

33. How do the senses of smell and taste differ?
   A. They differ in the types of receptors they employ.
   B. They differ in the reproductive rate of the receptors.
   C. They differ in their rate of sensory adaptation.
   D. They do not both employ cilia or hair-like extension of their receptor cells.
34. The diagram below shows human tongue: Identify the location of taste buds and the taste they represent.

35. The taste that most people sense on the back of the tongue is
   A. sweet
   B. bitter
   C. salty
   D. sour

36. Which of the following is not a mechanical stimulus?
   A. gravity
   B. sound
   C. touch
   D. vibration
   E. smell

37. Which of the following is not one of the four taste classes that taste buds respond to?
   A. bitter
   B. salty
   C. spicy
   D. sweet
38. The most sensitive vertebrate chemoreceptors known are the
   A. rod and cone cells of mammals
   B. taste receptors of fishes
   C. organs of Corti of humans
   D. olfactory receptors of mammals
   E. organs of Corti of bats

39. The heavy pressure sensor located where it is shown in Figure because:
   A. heavy pressure is not that important
   B. heavy pressure must push lower in the skin
   C. heavy pressure is really only felt in the epidermis
   D. heavy pressure is more damaging than light pressure

40. ------ collects the sound waves through the auditory canal to the ear drum
   A. cochlea
   B. pinna
   C. vestibule
   D. utricle
41. ------- contain receptors for static balance
   A. utricle
   B. saccule
   C. both a & b
   D. none of the above

42. What helps to equalize air pressure on either sides of the ear drum
   A. ear ossicles
   B. Eustachian tube
   C. pinna
   D. cochlea

43. The taste that most people sense on the sides of the tongue is
   A. sweet
   B. bitter
   C. salty
   D. sour

44. In the cochlea, the hair cells are contained by the
   A. tectorial membrane
   B. tympanic membrane
   C. basilar membrane
   D. vestibular membrane

45. The structure responsible for maintenance of equilibrium and posture:
   A. Vestibular apparatus
   B. Tympanic apparatus
   C. Cochlea
   D. Ear Drum

46. The membrane that separates the outer ear from the middle ear of mammals is called the
   A. foveal membrane
   B. basilar membrane
   C. oval window
   D. tectorial membrane
   E. tympanic membrane
47. Compared with chemical stimuli, auditory stimuli
   A. travel farther
   B. travel more quickly
   C. provide better directional information
   D. all of the above
   E. none of the above

48. The Eustachian tube connects the
   A. outer ear and middle ear
   B. middle ear and inner ear
   C. inner ear and throat
   D. cochlea and semicircular canals
   E. middle ear and throat

49. Sound waves do not travel through
   A. solids
   B. liquids
   C. gases
   D. vacuum

50. The frequency which is not audible to the human ear is
   A. 50 Hz
   B. 500 Hz
   C. 5000 Hz
   D. 50000 Hz

51. The technique used by bats to find their way or to locate food is _______.
   A. SONAR
   B. RADAR
   C. Echolocation
   D. Flapping

52. An example for mechanical wave
   A. Radio wave
   B. Light wave
   C. Infrared radiation
   D. Sound wave
53. The vibrations or the pressure variations inside the inner ear are converted into electrical signals by the _________.
   A. cochlea
   B. tympanic membrane
   C. pinna
   D. anvil

54. Vibrations inside the ear are amplified by the three bones namely the ________ in the middle ear.
   A. hammer, anvil and stirrup
   B. hammer, anvil and pinna
   C. hammer, cochlea and stirrup
   D. auditory bone, anvil and stirrup

55. Which of the following is not one of the ossicles in the middle ear of humans?
   A. stirrup
   B. anvil
   C. saddle
   D. hammer

56. Which of the following stimuli can be detected by a proprioceptor?
   A. taste
   B. pain
   C. color
   D. gravity
   E. all of the above

57. A person who lacked otoliths would probably have trouble
   A. seeing.
   B. hearing.
   C. sensing her body’s movement.
   D. sensing her body’s orientation.
   E. understanding this question.
58. The sensory neurons of the auditory system respond

A. directly to pressure changes in the air.
B. directly to pressure changes in the cochlear fluid.
C. to mechanical disturbances of the organ of Corti.
D. to chemical stimulation of the organ of Corti.
E. to fluid movements in the semicircular canals.

59. Which of the following is associated with sensing sound frequency and loudness?

A. Lateral geniculate nucleus in the thalamus
B. Semicircular canal
C. Oval window
D. Cochlea
E. Saccule and Utricle

60. The structure that forms the interface between the stapes and cochlea is the

A. tympanic membrane
B. basilar membrane
C. round window
D. oval window
### SCORING KEY

**DRAFT FORM OF ACHIEVEMENT TEST IN BIOLOGY - PART 1 & 2**

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## Appendix K

### Achievement Test: Difficulty Index and Discrimination Power

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APPENDIX L

ACHIEVEMENT TEST
ON THE TOPIC
“SENSE ORGANS”
(Based on Biology Textbook of Standard X State syllabus)
ACHIEVEMENT TEST IN BIOLOGY

(Standard x)

"Sense Organs"

Prepared by
TESSY JOSEPH KALLARACKAL, M.Sc., M.Phil., M.Ed.

Guided by
Dr. Celine Pereira
Reader
School of Pedagogical Science

MAHATMA GANDHI UNIVERSITY
KOTTAYAM
School of Pedagogical Sciences  
M. G. University  

ACHIEVEMENT TEST IN BIOLOGY  
Standard X  
Max Time: 60 min  
Max Scores: 40  

General instructions:  
Do not open this booklet until instructed.  
Fill in your name, class, division and school on the answer sheet provided.  
You must record your answers on the Answer sheet.  
Attempt all questions.  
There are 40 multiple choice questions in total (1-40).  
Choose the BEST answer from the four possible options.  
Mark only ONE answer for each question.  
Scores are NOT deducted for incorrect answers.  
Each question carries 1 score.  
On your answer sheet write the letter that matches your answer.  
Rub out any mistakes completely.  
Answer the questions after reading the directions and instructions related to each question.
1. Small elevations on the tongue which contain taste buds are known as:
   A. Receptors
   B. Papillae
   C. Humps
   D. Gyri

2. The Eustachian tube connects the:
   A. Outer ear and middle ear
   B. Middle ear and inner ear
   C. Inner ear and throat
   D. Middle ear and throat

3. "Tuning out" background sounds while you study is possible because of a phenomenon called:
   A. Para consciousness
   B. Selective receptivity
   C. Concentration
   D. Sensory adaptation

4. Identify the ear ossicle "A" & “B” in the diagram given below.

   ![Diagram of ear ossicles]

   A. A-incus B-stapes
   B. A-malleus B-incus
   C. A-incus B-malleus
   D. A-malleus B-stapes
5. Which part of the internal ear is meant for hearing?
   
   A. Ear Drum  
   B. Cochlea  
   C. Auditory Bones  
   D. Semicircular canals

6. A person who lacked otoliths would probably have trouble in:
   
   A. Seeing.  
   B. Hearing.  
   C. Sensing the body’s movement.  
   D. Sensing the body’s orientation.

7. The function of structure 2 in the diagram given below is:
   
   A. To maintain body balance.  
   B. To control muscular movement.  
   C. To detect head movement.  
   D. To detect body position.

8. Receptors for static balance are present in:
   
   A. Utricle  
   B. Saccule  
   C. Semicircular canals  
   D. Both A & B
9. Which of the following describes the correct relationships between different structures of the eyeball?

<table>
<thead>
<tr>
<th>Ciliary muscles</th>
<th>Suspensory ligament</th>
<th>Lens</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. contracted</td>
<td>tension increased</td>
<td>thick</td>
</tr>
<tr>
<td>B. contracted</td>
<td>tension decreased</td>
<td>thin</td>
</tr>
<tr>
<td>C. relaxed</td>
<td>tension decreased</td>
<td>thick</td>
</tr>
<tr>
<td>D. relaxed</td>
<td>tension increased</td>
<td>thin</td>
</tr>
</tbody>
</table>

10. When a person reads through a page, only a few words can be seen clearly each time. This is because:

A. Most of the words cannot be focused onto the retina.
B. Only a few words can be focused onto the yellow spot.
C. Some words are focused onto the blind spot.
D. The brain can only interpret a few words each time.

11. Middle ear infection may follow a throat infection because:

A. The Eustachian tube opens into the base of the inner ear
B. The Eustachian tube opens into the base of the middle ear.
C. The vestibulocochlear nerve passes through the tympanic cavity
D. Answers A and C.

12. Which of the following is not true concerning the olfactory system of mammals?

A. Olfactory receptors are restricted to the nasal cavity.
B. The “cilia” of olfactory neurons are not true cilia.
C. The olfactory sensory cells are epithelial cells.
D. The olfactory sensory cells are replaced by every 60 days.

13. A sensory receptor capable of detecting changes in hydrogen ion concentration is more accurately described as a:

A. Thermoreceptor
B. Pain receptor
C. Mechanoreceptor
D. Chemoreceptor
14. The two sac-like structures of the inner ear called the utricle and saccule:
   A. contain a fluid called perilymph
   B. contain a fluid called endolymph
   C. function as part of the auditory system
   D. answers A and C

15. The structure responsible for maintenance of equilibrium and posture:
   A. Vestibular apparatus
   B. Tympanic apparatus
   C. Cochlea
   D. Ear Drum

16. In the vestibular system, otolith organs detect _______ and semicircular canals are sensitive to _______
   A. head rotation to the left / head rotation to the right
   B. head rotation to the left / tilts of the head
   C. head rotations / force of gravity
   D. force of gravity / rotations of the head

17. Which of the following statements about short sight is / are true?
   (1) The eyeball is too long.
   (2) Distant objects are focused in front of the retina.
   (3) A convex lens is used for its correction.
   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3).

18. Why do we move our hands while walking?
   A. To relieve our tension
   B. To walk faster
   C. To maintain equilibrium against force of gravity
   D. To increase blood circulation and oxygen supply

Directions: Answer the questions 19 and 20 on the basis of the graph given below which shows the changes of the lens thickness of a boy's eye within 10 seconds:
19. What changes occur in the boy's eye between the 2nd and 4th seconds?

A. The pupil is dilating.
B. The ciliary muscles are relaxing.
C. The suspensory ligaments are contracting.
D. The tension on the suspensory ligaments is decreasing.

20. Between the 6th and the 8th second, the boy is looking at:

A. a far away stationary object.
B. a nearby stationary object.
C. an object is moving towards him.
D. an object is moving away from him

21. After a car accident, a man had problem in balancing himself during walking. However, he could still hear well. What body structures might have been damaged?

(1) Cerebrum
(2) cerebellum
(3) cochlea
(4) semicircular canals

A. (1) and (3) only
B. (1) and (4) only
C. (2) and (3) only
D. (2) and (4) only
22. Construct a flow chart that shows what happens inside the black box of hearing by arranging the names given below in the correct order.

A. Tympanic membrane (eardrum)  B. Ossicles
C. Pinna (outer ear)          D. Cochlea
E. Brain,                           F. Auditory nerve,
G. Organ of Corti,               H. Auditory canal
I. Oval window

23. Which of the following occurs when a person is going up in a lift from ground floor to 20th floor?

<table>
<thead>
<tr>
<th>Change in atmospheric pressure</th>
<th>Movement of eardrum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. increase</td>
<td>bulge inwards</td>
</tr>
<tr>
<td>B. increase</td>
<td>bulge outwards</td>
</tr>
<tr>
<td>C. decrease</td>
<td>bulge inwards</td>
</tr>
<tr>
<td>D. decrease</td>
<td>bulge outwards</td>
</tr>
</tbody>
</table>

24. How do the senses of smell and taste differ?

A. They differ in the types of receptors they employ.
B. They differ in the reproductive rate of the receptors.
C. They differ in their rate of sensory adaptation.
D. They do not both employ cilia or hair-like extension of their receptor cells.
25. When a drop of sucrose solution was put onto the sides of a girl's tongue, it did not taste sweet to her. A possible conclusion is that:

A. The girl's tongue is not sensitive to sucrose solution.
B. Sucrose solution is not as sweet as glucose solution.
C. No sensory cells for sweet taste are present on the sides of the girl's tongue.
D. Sensory cells for sweet taste are only present at the tip of the girl's tongue.

26. Many people suffer sea-sickness when travelling on boats. This sickness is caused by over-stimulation of:

A. Structure 1.
B. Structure 2.
C. Structure 3.
D. Structure 4

27. When compared with chemical stimuli, auditory stimuli:

A. Travel farther
B. Travel more quickly
C. Provide better directional information
D. All of the above

28. Trace the path of light through the eye to the retina, and on to the primary visual cortex? (List in order)

A) cornea    B) rods and cones,    C) retinal ganglion cells,
D) lens      E) aqueous humor,    F) vitreous humor
G) conjunctiva
29. Which regions are filled with air?

A. 2 and 4  
B. 4 and 5  
C. 5 and 6  
D. 6 and 7

30. When a person tries to focus on a distant object, which of the following changes occurs?

<table>
<thead>
<tr>
<th>Structure 2</th>
<th>Structure 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. contracts</td>
<td>more convex</td>
</tr>
<tr>
<td>B. contracts</td>
<td>less convex</td>
</tr>
<tr>
<td>C. stretched</td>
<td>more convex</td>
</tr>
<tr>
<td>D. stretched</td>
<td>less convex</td>
</tr>
</tbody>
</table>
31. Which of the following are functions of structure 2?

(1) To amplify vibrations
(2) To transmit vibrations
(3) To equalize the pressure on both sides of structure 1

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

32. Which set includes only general senses?

A. Temperature, pain, touch, stretch, and pressure
B. Pain, pressure, balance, taste, and smell
C. Vision, hearing, balance, smell, and taste
D. Equilibrium, vibration, hearing, touch, and vision

33. If you place a drop of honey or a sugar cube into your mouth, which food will stimulate the sweet taste buds first?

A. Sugar cube
B. Honey
C. There is no difference

34. The most sensitive vertebrate chemoreceptors known are the:

A. Rod and cone cells of mammals
B. Organs of Corti of humans
C. Olfactory receptors of mammals
D. Organs of Corti of bats
35. The drawing below shows a light ray diagram of a defective human eye, and two types of lens for correcting certain eye defects. What is this eye defect and how may it be corrected?

<table>
<thead>
<tr>
<th>Eye defect</th>
<th>Lens to be used for correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. long sight</td>
<td>lens I</td>
</tr>
<tr>
<td>B. long sight</td>
<td>lens II</td>
</tr>
<tr>
<td>C. short sight</td>
<td>lens I</td>
</tr>
<tr>
<td>D. short sight</td>
<td>lens II</td>
</tr>
</tbody>
</table>

36. The diagram below shows a section of a certain part of the human ear. The receptor will be stimulated when:

A. the head turns.
B. the eardrum vibrates.
C. the perilymph moves.
D. the atmospheric pressure changes.
37. The heavy pressure sensor located where it is shown in Figure because heavy pressure:

A. Is not that important  
B. Must push lower in the skin  
C. Is really only felt in the epidermis  
D. Is more damaging than light pressure

38. A child was watching a bee which was flying away from him and landing on a flower. Which of the following graphs shows the change in the curvature of the lens of his eye?
39. The diagram below was drawn by a student to show the path of light rays when a long-sighted person was looking at a near object: What is wrong with this diagram?

**Long sight (Hypermetropia)**

A. The rays should be focused on the retina.
B. The rays should be focused behind the retina.
C. The lens used is not correct.
D. Eye ball should be long

40. The diagram below shows human tongue: Identify the location of taste buds and the taste they represent.
## SCORING KEY

### ACHIEVEMENT TEST IN BIOLOGY

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>Answer</th>
<th>Q. No.</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>D</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
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<td>C-H-A-B-I-D-G-F-E.</td>
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<td>3</td>
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<td>23</td>
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</tr>
<tr>
<td>19</td>
<td>D</td>
<td>39</td>
<td>B</td>
</tr>
<tr>
<td>20</td>
<td>C</td>
<td>40</td>
<td>I. Bitter; 2. Sour; 3. Salt; 4. Sweet</td>
</tr>
</tbody>
</table>