APPENDICES
## Table: List of instruments

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the equipment</th>
<th>Model/ Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B.O.D Incubator</td>
<td>Metrex Scientific Instruments Pvt. Ltd, New Delhi, India</td>
</tr>
<tr>
<td>2</td>
<td>Biochemical analyzer</td>
<td>Biochemical Systems, International Sale, Italy</td>
</tr>
<tr>
<td>3</td>
<td>Confocal Imaging Instrument</td>
<td>Leica TCS SP2 UV Confocal Imaging system, USA</td>
</tr>
<tr>
<td>4</td>
<td>Deep Freezer</td>
<td>Vestfrost Household, Esbjerg, USA</td>
</tr>
<tr>
<td>5</td>
<td>Digital balance</td>
<td>Shinko Sansui, Japan</td>
</tr>
<tr>
<td>6</td>
<td>Digital pH meter</td>
<td>Elico-LI 120Ph (type003), Hyderabad, India</td>
</tr>
<tr>
<td>7</td>
<td>Differential scanning colorimetry</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>DSC apparatus</td>
<td>Perkin Elmer, USA</td>
</tr>
<tr>
<td>9</td>
<td>Digital $pH$ meter</td>
<td>MP 220, Mettler Toledo, USA</td>
</tr>
<tr>
<td>10</td>
<td>Distillation unit</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Dose Calibrator</td>
<td>Capnitch. Inc., New Jersey, USA</td>
</tr>
<tr>
<td>12</td>
<td>Electronic Balance</td>
<td>India Mettler AT-26L Delhi, India</td>
</tr>
<tr>
<td>13</td>
<td>Electro cardiograph</td>
<td>Biopac Systems, Inc, USA</td>
</tr>
<tr>
<td>14</td>
<td>FT-IR spectrophotometer</td>
<td>Shimadzu-8400 S, Japan</td>
</tr>
<tr>
<td>15</td>
<td>Fluorescence spectroscopy equipment</td>
<td>Spectramax M₂ Germany</td>
</tr>
<tr>
<td>16</td>
<td>Franz Diffusion Cell</td>
<td>Logan Instrument Cooperation, Delhi, India</td>
</tr>
<tr>
<td>17</td>
<td>Gamma camera</td>
<td>M/s Siemen Limited, Symbia T₂, USA</td>
</tr>
<tr>
<td>18</td>
<td>High Performance Liquid Chromatography (HPLC)</td>
<td>Agilent Technology Waldbronn, Germany</td>
</tr>
<tr>
<td>19</td>
<td>Hot air oven</td>
<td>Tempo, Mumbai, India</td>
</tr>
<tr>
<td>20</td>
<td>Human tissue equivalent model</td>
<td>Gammex RMI® ,WC,USA</td>
</tr>
<tr>
<td>22</td>
<td>Hematology analyzer</td>
<td>Helet Schloesing Laboratories, France</td>
</tr>
<tr>
<td>23</td>
<td>Hot air oven</td>
<td>Windsons Scientific Works, Delhi, India</td>
</tr>
<tr>
<td>24</td>
<td>High Speed Refrigerated Micro Centrifuge</td>
<td>Tomy Mx-305, Tomy kogyo Co. Ltd., Tokyo, Japan</td>
</tr>
<tr>
<td>25</td>
<td>Humidity Chamber</td>
<td>Topsun Energy Ltd. Delhi, India</td>
</tr>
<tr>
<td></td>
<td>Equipment Description</td>
<td>Supplier/Manufacturer</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>26</td>
<td>ITLC SG Strips</td>
<td>Gelman Sciences Inc., USA</td>
</tr>
<tr>
<td>27</td>
<td>Injection Syringes</td>
<td>Dispovan, New Delhi, India</td>
</tr>
<tr>
<td>30</td>
<td>KBr Press</td>
<td>Techno search instruments, India</td>
</tr>
<tr>
<td>31</td>
<td>Magnetic stirrer</td>
<td>Remiequipments, Mumbai, India</td>
</tr>
<tr>
<td>32</td>
<td>Microtome</td>
<td>Spencers Motorized Micro-tome, Japan</td>
</tr>
<tr>
<td>33</td>
<td>Mechanical Stirrer</td>
<td>Remi Equipments, Mumbai, India</td>
</tr>
<tr>
<td>34</td>
<td>Melting Point Apparatus</td>
<td>Nirmal International, Delhi, India</td>
</tr>
<tr>
<td>35</td>
<td>Nanosizer/Zetasizer</td>
<td>Nanosizer/Zetasizer ZS Malvern Instruments, Worcestershire, UK</td>
</tr>
<tr>
<td>36</td>
<td>Nuclear magnetic resonance spectroscopy equipment</td>
<td>Bruker AM 400 MHz. Germany</td>
</tr>
<tr>
<td>37</td>
<td>Prove Homogenizer</td>
<td>L5M-A lab mixer Silverson UK</td>
</tr>
<tr>
<td>38</td>
<td>Radio-calibrator</td>
<td>Radiopac Systems, Inc, USA</td>
</tr>
<tr>
<td>39</td>
<td>R/S CPS Plus Rheometer</td>
<td>Brookfield Engineering Laboratorie, Inc., Middleboro, MA, USA</td>
</tr>
<tr>
<td>40</td>
<td>Sonicator</td>
<td>PCI, Mumbai, India</td>
</tr>
<tr>
<td>41</td>
<td>Transmission electron microscopy (TEM)</td>
<td>Morgagni 268D, FEI, Holland</td>
</tr>
<tr>
<td>42</td>
<td>UV-visible spectrophotometer</td>
<td>CECIL Ins, Cambridge, England</td>
</tr>
<tr>
<td>43</td>
<td>Weighing balance</td>
<td>Sartorius, Germany</td>
</tr>
<tr>
<td>44</td>
<td>Well type gamma camera</td>
<td>Capintech, USA</td>
</tr>
<tr>
<td>45</td>
<td>Weighing balance</td>
<td>Sartorius, Germany</td>
</tr>
<tr>
<td>46</td>
<td>Whatman Filter paper</td>
<td>Whatman International Limited, England</td>
</tr>
</tbody>
</table>
## Table: List of chemicals

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Disodium etyliene diamine tetraacetic acid (Disodium edetate)</td>
<td>Merck, Mumbai, India</td>
</tr>
<tr>
<td>2</td>
<td>Diethylene triamine tetraacetic acid (DTPA)</td>
<td>Lancaster, Mumbai, India</td>
</tr>
<tr>
<td>3</td>
<td>Sodium Carboxy Methyl Cellulose (Na-CMC)</td>
<td>CDH Ltd. Mumbai, India</td>
</tr>
<tr>
<td>4</td>
<td>Propyliene glycol</td>
<td>CDH Ltd. Mumbai, India</td>
</tr>
<tr>
<td>5</td>
<td>Carbopol 934</td>
<td>CDH Ltd. Mumbai, India</td>
</tr>
<tr>
<td>6</td>
<td>Methyl paraben</td>
<td>Titan Biotech Ltd., Rajasthan, India</td>
</tr>
<tr>
<td>7</td>
<td>Propyl praben</td>
<td>Titan Biotech Ltd., Rajasthan, India</td>
</tr>
<tr>
<td>8</td>
<td>Polyvinyl alcohol (PVA cold)</td>
<td>Titan Biotech Ltd., Rajasthan, India</td>
</tr>
<tr>
<td>9</td>
<td>Sodium carboxymethyl cellulose</td>
<td>CDH Ltd. Mumbai, India</td>
</tr>
<tr>
<td>10</td>
<td>Talcum</td>
<td>CDH Ltd. Mumbai, India</td>
</tr>
<tr>
<td>11</td>
<td>Triethylonamine</td>
<td>Fisher Scientific, Mumbai, India</td>
</tr>
<tr>
<td>12</td>
<td>Sodium chloride</td>
<td>Hi Media, Mumbai, India</td>
</tr>
<tr>
<td>13</td>
<td>EDTA solution</td>
<td>Fisher Scientific, Mumbai, India</td>
</tr>
<tr>
<td>14</td>
<td>Di sodium edtate</td>
<td>Merck Ltd, Mumbai, India</td>
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<td>15</td>
<td>Diethyline triamine tetraacetic acid</td>
<td>Lancaster, England</td>
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<tr>
<td>16</td>
<td>Propylene glycol</td>
<td>CDH Ltd. Mumbai, India</td>
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<td>17</td>
<td>Formaldehyde</td>
<td>Qualigens Fine Chemicals, Mumbai, India</td>
</tr>
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<td>18</td>
<td>Depilator</td>
<td>Jolen, India</td>
</tr>
<tr>
<td>19</td>
<td>Sodium hydroxide</td>
<td>Merck Specialities Pvt Ltd, Mumbai, India</td>
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<td>20</td>
<td>Diethyl ether</td>
<td>Merck Specialities Pvt Ltd, Mumbai, India</td>
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<td>21</td>
<td>Ethanol</td>
<td>Changshu Yangyuan</td>
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<tr>
<td>22</td>
<td>EDTA solution</td>
<td>HIMEDIA Laboratories Pvt. Ltd., Mumbai, India</td>
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<tr>
<td>23</td>
<td>Formaldehyde solution</td>
<td>Qualigens Fine Chemicals, Mumbai, India</td>
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<tr>
<td>24</td>
<td>Di ethyl ether</td>
<td>Merck Specialities Pvt. Ltd., Worli,</td>
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<tr>
<td>No.</td>
<td>Item</td>
<td>Supplier</td>
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<td>-----</td>
<td>-------------------------------------</td>
<td>-----------------------------------------</td>
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<tr>
<td>25</td>
<td>Ethyl alcohol</td>
<td>Changshu Yangyuan Chemicals, China</td>
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<tr>
<td>26</td>
<td>Acrylamide, tris-buffer</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<tr>
<td>27</td>
<td>Merceptoethanol</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<tr>
<td>28</td>
<td>Bis acrylamide</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<td>29</td>
<td>Bromophenol blue</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<td>30</td>
<td>Sodium Dodecyl Sulphate</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<td>31</td>
<td>Methnol</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<td>32</td>
<td>HCl</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<td>33</td>
<td>NaCl</td>
<td>Sigma Aldrich, Mumbai, India</td>
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<td>34</td>
<td>Primary antibody</td>
<td>Santa cruz, biotechnology</td>
</tr>
<tr>
<td>35</td>
<td>Secondary antibody Amresco (western Max horseradish peroxidase chromogenic detection kit, Mouse)</td>
<td>Merck, Germany</td>
</tr>
<tr>
<td>36</td>
<td>Porablolt PVDF membrane</td>
<td>Merck Specialities Pvt. Worli, Mumbai</td>
</tr>
<tr>
<td>37</td>
<td>Tween 80</td>
<td>Sigma Aldrich, Mumbai, India</td>
</tr>
<tr>
<td>38</td>
<td>Span 80</td>
<td>Sigma Aldrich, Mumbai, India</td>
</tr>
<tr>
<td>39</td>
<td>Paraffin oil</td>
<td>Sigma Aldrich, Mumbai, India</td>
</tr>
<tr>
<td>40</td>
<td>Carbopol</td>
<td>CDH Ltd. Mumbai, India</td>
</tr>
</tbody>
</table>
Medical radioisotopes used as Radiological Contaminants

Three medical radio-isotopes (\(^{99m}\)Tc, \(^{201}\)Tl, and \(^{131}\)I), were selected as radiological contaminants. \(^{99m}\)Tc is the most commonly used medical radioisotope (about 80%) of all diagnostic administrations of radiopharmaceuticals due to its highly suitable physical characteristics such as its short half-life and quick assimilation into the body. \(^{131}\)I comes in a distant second and \(^{201}\)Tl least used being limited to myocardial perfusion and stress tests. The mean dose per procedure in nuclear medicine is 4.6 mSv (UNSCEAR, 2000).

\(^{99m}\)Tc is used in the majority of nuclear medicine diagnostic procedures due to having many ideal characteristics such as a short half-life of six hours, emits gamma rays of low energy (140 keV), emits no particles as part of its decay pattern, is an easily labeled radionuclide which allows for uptake by specific organs, is readily excreted by the patient, and is easily generated in the radiopharmacy (Graham and Cloke, 2003). It is used in diagnostic tests for imaging of organs or organ physiology such as renal function, and imaging of the brain, kidney, liver, lung, skeleton, or spleen (Graham and Cloke, 2003). It is also used in cardiac blood pool imaging, liver-spleen scanning, lung perfusion scans, lung ventilation scans, myocardial perfusion imaging, and thyroid imaging (Diagnostic Tests, 2004).

\(^{131}\)I is used in both diagnostic procedures and for therapy. It has a physical half-life of eight days, emits gamma rays at 364 keV, and is specifically taken up by the thyroid. It is used for a number of disease diagnoses. Along with this, fallout results in the release of the iodine-131 in the form of liquid or gas, as a major hazard that could inter inside the body through inhalation along with the absorption through the intact or broken skin. \(^{131}\)I is major uranium, plutonium fission product; comprising nearly 3% of the total products of fission (by weight). It could severely damage body due to release of 10% gamma and 90% of beta radiation (Wagner et al., 1994; Harrison, 1963). In view of this iodine-131 was selected as radiological skin contaminant and investigated for the decontamination efficacy of the optimized formulations.

\(^{201}\)Tl is used in diagnostic treatments of the heart. It has a half-life of about three days (73.1 hours), and emits gamma rays at 135 & 167 keV and a mercury x-ray at 80.3 keV recommended for myocardial imaging (Mallinckrodt, 1995; Mallinckrodt, 1995). The chemical properties are also similar with the alkai metal such as cesium seeks for longer muscles and myocardium. Cesium, a fallout product is a major health hazard because of its
long half-life (30 y) and emission of high energy gamma radiation causes whole body exposure as well as contamination. In view of this, $^{201}$Tl was selected as a radiological experimental contamination model for evaluation of the effectiveness of the developed formulations.

**Selectivity of Target Radio-contaminants**

$^{99m}$Tc and $^{131}$I were obtained from Regional Centre for Radiopharmaceuticals, Board of Radiation and Isotope Technology (BRIT), Institute of Nuclear Medicine and Allied Sciences (INMAS), Brig. S. K. Mazumdar Road, Delhi, India. Thallium-201 was obtained as a gift from the Nuclear Medicine Department of the All India Institute of Medical Sciences (AIIMS), Delhi, India.

**Table 1: Isotopes used in study**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Isotopes</th>
<th>Form</th>
<th>Mass</th>
<th>Energy (keV)</th>
<th>Half-life</th>
<th>Mode of decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$^{99m}$Tc</td>
<td>Sodium Pertechnetate (NaTcO$_4$)</td>
<td>98.91</td>
<td>140</td>
<td>6.020 h</td>
<td>$\rightarrow ^{99}$Ru</td>
</tr>
<tr>
<td>2</td>
<td>$^{131}$I</td>
<td>USP as Sodium Iodide TX Sol.</td>
<td>131</td>
<td>606</td>
<td>8 days</td>
<td>$\rightarrow ^{131}$Xe</td>
</tr>
<tr>
<td>3</td>
<td>$^{201}$Tl</td>
<td>Thallous Chloride</td>
<td>201</td>
<td>135-167</td>
<td>3 days</td>
<td>$\rightarrow ^{201}$Pb</td>
</tr>
</tbody>
</table>
Experimental models

i. A human tissue equivalent procured from Gammex RMI®, Winconsin, USA, was used for standardization of protocol for evaluation of the decontamination efficacy (DE) and as a model for comparison of DE of different formulations using a variety of contaminants.

![Human Tissue equivalent](image)

ii. Sprague-Dawley adult male and female rat 2-3 months old and 180±20 gm weight, inbred in the animal house of the Institute of Nuclear Medicine and Allied Sciences, Delhi, were used for the experiments. Animals were kept under standard laboratory condition with photoperiod of 12 h / day and temperature of 25±2°C. Rats were housed individually in polyvinyl cage and fed standard animal food pellets (Golden Feeds, Delhi, India) and was offered *ad libitum*. All the procedures were carried out in strict compliance with the Institutional Animal Ethics Committee (IAEC) rules and regulation followed in this institute.

iii. Rabbit New Zealand white strain model, 3-4 months weighing 2.0± 0.25 kg were used as the experimental model after obtaining Institutional Animal Ethics Committee approval. All animals were given normal feed *ad libitum*, and filtered drinking water. Rabbits were kept at normal room temperature of 25±2°C and in 12 hours each of dark and light periods.
### Excipients profile

**i. TWEEN 80**

<table>
<thead>
<tr>
<th><strong>Synonym</strong></th>
<th>Polyoxyethylene Sorbitan Monooleate, Alkest TW 80, Canarcel</th>
</tr>
</thead>
</table>

| **Chemical name** | Polyoxyethylene (20) sorbitan monooleate |
| **Category** | Used in cosmetics, used as an emulsifier in foods, surfactant in aqueous formulations, preparation of Nanoemulsion |
| **Molecular formula** | C_{64}H_{124}O_{26} |
| **Molecular weight** | 648.91 g/mol |

**Physicochemical properties**

- **Appearance**: Amber coloured
- **State**: Viscous liquid
- **Melting points**: 300 °C
- **Density**: 1.06–1.09 g/mL, oily liquid
- **Viscosity**: 300–500 centistokes (@25°C)
- **HLB**: 4.3
- **Solubility**: Water
- **Molar mass**: 1310 g/mol
### ii. SPAN 80

<table>
<thead>
<tr>
<th>Synonym</th>
<th>Ionets80, Montan80, Sorgen40, Armotanmo, Glycomulo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular formula</td>
<td>C_{24}H_{44}O_{6}</td>
</tr>
<tr>
<td>Molecular weight</td>
<td>428.6</td>
</tr>
<tr>
<td>Physical properties</td>
<td></td>
</tr>
<tr>
<td>Appearance</td>
<td>Odorless yellow liquid</td>
</tr>
<tr>
<td>State</td>
<td></td>
</tr>
<tr>
<td>Melting points</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>0.994 g/mL at 20 °C</td>
</tr>
<tr>
<td>HLB</td>
<td>4.6 ± 0.1</td>
</tr>
<tr>
<td>Solubility</td>
<td>Water, Soluble in ethanol (95%), cottonseed oil, corn oil, ethyl acetate, methanol, toluene and other organic solvents</td>
</tr>
<tr>
<td>Molar mass</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7-8</td>
</tr>
</tbody>
</table>
### Paraffin oil

<table>
<thead>
<tr>
<th><strong>Synonym</strong></th>
<th>Adepsine oil, Alboline, Bayol 55, Bayol F, Blandlube, Crystol 325, Crystosol, Glymol, Kondremul</th>
</tr>
</thead>
</table>

**Chemical name**  
Low molecular weight paraffinic oil

**Category**

**Molecular formula**  
Paraffin is used synonymously with "alkane", indicating hydrocarbons with the general formula C\(_n\)H\(_{2n+2}\)

**Molecular weight**

**Physicochemical properties**

- **Appearance**  
  Clear, colourless liquid with neutral odour
- **State**  
  Liquid
- **Melting points**  
  -17.8°C
- **Density**  
  0.851 - 0.869 kg/L
- **Viscosity**  
  36 - 240 c. St
- **Solubility**  
  Insoluble in water
- **Molar mass**  
  -
- **Freeze point**  
  -12 - 15°C
- **Boiling point**  
  350 - 535°C
- **SG/Density**  
  0.86 g/cm³
- **Viscosity 110**  
  125 Pas
- **Stability**  
  Stable
- **Dose (dermal)**  
  332 gm/kg mouse body weight
- **Relative density**  
  0.8 to 0.9 (Water = 1)