3. Nirjantukarana (Sterilization)

3. Nirjantukaraṇa (Sterilization & Asepsis)

Learning goal

By the end of this chapter you will (1) classify and choose correct **sterilization** and **disinfection** methods for instruments, dressings, OT air/surfaces, and hands; (2) describe the **Vraṇitāgāra** (ward/OT) as per Suśruta and translate it to modern OT design; and (3) perform **hand wash**, **gowning**, and **gloving** to exam standard.

---

1) Foundations: terms you must use correctly

- **Nirjantukaraṇa (Sterilization):** Complete destruction/removal of **all** forms of microbial life, including spores (e.g., steam under pressure, dry heat, gas/plasma, radiation, sterilizing filtration).
- **High-level disinfection (HLD):** Kills all organisms **except large numbers of spores** (e.g., 2% glutaraldehyde, 0.55% OPA).
- **Intermediate-/Low-level disinfection:** Kills mycobacteria/some viruses (intermediate) or vegetative bacteria and some viruses (low).
- **Asepsis:** Practices that keep tissues/instruments **free from contamination** during procedures.
- **Antisepsis:** Use of agents on **living tissue** (e.g., alcoholic chlorhexidine, povidone-iodine).
- **Spaulding classification:**
  - **Critical** items (enter sterile tissues/vascular system) → **Sterilize**.
  - **Semi-critical** (contact mucosa) → **HLD**.
  - **Non-critical** (intact skin) → **cleaning ± low/intermediate disinfection**.

---

2) Vraṇitāgāra (classical ward/OT concept) → design essentials today

Vraṇitāgāra Classical references from Sushruta Samhita Sutra Sthan Chapter 19. व्रणितोपासनीयम् –

Proper Room First (Sū. 19/3)
व्रणितस्य प्रथममेवागारमन्विच्छेत् तच्चागारं प्रशस्तवास्त्वादिकं कार्यम् ॥३॥
First of all, arrange a dwelling for the wound-patient; that room should be made proper, with auspicious layout (vāstu) and related features.

Clean, Draft-Free House (Sū. 19/4)
प्रशस्तवास्तुनि गृहे शुचावातपवर्जिते । निवाते न च रोगाः स्युः शारीरागन्तुमानसाः ॥४॥
In a well-planned, clean house, avoiding harsh sun; in a draft-free place, bodily, exogenous, and mental illnesses do not arise.

Bed Arrangement (Sū. 19/5)
तस्मिञ् शयनमसंबाधं स्वास्तीर्णं मनोज्ञं प्राक्शिरस्कं सशस्त्रं कुर्वीत ॥५॥
There, prepare a bed that is spacious, well-spread, and pleasant; place the head to the east, with necessary instruments kept ready.

Head to the East; Comfortable Movement (Sū. 19/6)
सुखचेष्टाप्रचारः स्यात् स्वास्तीर्णे शयने व्रणी । प्राच्यां दिशि स्थिता देवास्तत्पूजार्थं च तच्छिरः ॥६॥
On a well-spread bed the patient should move comfortably; since the gods dwell in the east, his head should face east for reverence.

Companionship & Consolation (Sū. 19/7–8)

तस्मिन् सुहृद्भिरनुकूलैः प्रियंवदैरुपास्यमानो यथेष्टमासीत ॥७॥
सुहृदो विक्षिपन्त्याशु कथाभिर्व्रणवेदनाः आश्वासयन्तो बहुशः स्वनुकूलाः प्रियंवदाः ॥८॥
There he should remain as he wishes, attended by friendly, supportive, pleasant-speaking companions. Such friends quickly distract the pain of the wound with conversations, repeatedly comforting him with kind words.

Avoid Daytime Sleep (Sū. 19/9–10)
न च दिवानिद्रा वशगः स्यात् ॥९॥
दिवास्वप्नाद्व्रणे कण्डूर्गात्राणां गौरवं तथा श्वयथुर्वेदना रागः स्रावश्चैव भृशं भवेत् ॥१०॥
He should not succumb to day-sleep. Because of day-sleep there is intense itching in the wound, heaviness of the limbs, swelling, pain, redness, and profuse discharge.

Protective Rites & Fumigation (Sū. 19/27–28, 30)
ऋग्यजुःसामाथर्ववेदाभिहितैरपरैश्चाशीर्विधानैरुपाध्याया भिषजश्च सन्ध्ययो रक्षां कुर्युः ॥२७॥
सर्षपारिष्टपत्राभ्यां सर्पिषा लवणेन च द्विरह्नः कारयेद् धूपं दशरात्रम् अतन्द्रितः ॥२८॥
…
व्यज्येत बालव्यजनैर्व्रणं न च विघट्टयेत् न तुदेन्न च कण्डूयेच्छयानः परिपालयेत् ॥३०॥
Teachers and physicians should perform protective benedictions at dawn and dusk using blessings taught in the Ṛg, Yajus, Sāman, and Atharva Vedas and other rites. Fumigate twice daily for ten nights—using mustard and neem leaves with ghee and salt—without negligence. Fan the wound gently with small fans; do not disturb it, prick it, or scratch it; keep to bed and safeguard it.

Obey the Physician; Draft-Free Living (Sū. 19/35)
दिवा न निद्रा वशगो निवातगृहगोचरः व्रणी वैद्यवशे तिष्ठञ् शीघ्रं व्रणमपोहति ॥३५॥
Avoid day-sleep and remain within a draft-free house; the wound-patient who stays under the physician's guidance quickly becomes free of the wound.

Explain for exam answers (what this verse implies):

- **Asambādha (spacious):** crowd-free OT/ward; adequate **working clearance** on all sides.
- **Sastīrṇa (well-spread):** clean linen/OT draping; **lint-free** materials.
- **Manojña (pleasant):** well-lit, well-ventilated; **thermal comfort** supports recovery.
- **Prāk-śiraska (east-facing head end):** classical orientation → today: **consistent bed orientation** for workflow and light direction.
- **Sa-śastra (with instruments):** instruments **ready, complete, sterile**—mirrors modern **OT sets & trays** discipline.

Use this śloka when describing **ward/OT layout** in theory papers, then add modern infection-control language as below.

---

3) Sterilization — methods & types (what, where, and key parameters)

A) Moist heat (steam under pressure / autoclave) — method of choice

- **121 °C at 15 psi for 15–30 min** (gravity displacement) or **134–135 °C for 3–4 min** (pre-vacuum/flash for unwrapped emergencies).
- Suitable for **metal instruments, textile packs** (if compatible).
- **Process control:** physical gauges, chemical indicators (Class 1–6), **biological indicator** (Geobacillus stearothermophilus) weekly/each load per policy.
- **Pitfalls:** air pockets, over-loading, wet packs; fix by proper **packaging, load layout, and pre-vacuum** cycles.

B) Dry heat (hot-air oven)

- **160 °C for 120 min** or **170 °C for 60 min**.
- For **glassware, metal** where moisture corrodes; **not** for most plastics, rubber.

C) Gas sterilization (ETO)

- For **heat-/moisture-sensitive** items (complex plastics, lumened devices).
- Aeration required (ETO residues); longer turnaround.

D) Low-temperature plasma (H_2O_2 plasma / vapor)

- Fast cycles; for many heat-sensitive devices; **avoid** cellulose-based materials inside the chamber.

E) Radiation sterilization (industrial)

- **Gamma/e-beam** for single-use disposables (syringes, catheters) at manufacturer level.

F) Sterilizing filtration

- **0.22 µm** membrane for **liquids/heat-labile solutions** (parenterals); remember **aseptic technique** during filtration and filling.

Exam cue: If it **enters sterile tissue** → choose **autoclave** if compatible; else **ETO/plasma**. For **liquids** → **filtration** (not heat). For **powders/oils** → dry heat.

---

4) Disinfection of instruments & surfaces (when sterilization is not applicable)

Device reprocessing sequence (always write in order)

Point-of-use pre-clean → Transport → Cleaning (enzymatic/manual/ultrasonic) → Inspect → Package → Sterilize/HLD → Store.

High-level disinfectants (HLD) for semi-critical devices

- **2% Glutaraldehyde** (activation per label; typical >20 min HLD contact; thorough rinse).
- **0.55% Ortho-phthalaldehyde (OPA)** (≈12 min; rinse).
- **High-strength hydrogen peroxide/peracetic acid** systems (automated washers for endoscopes).

Environmental/OT surface disinfection

- **Alcohol 70%** (rapid, no spores), **1% sodium hypochlorite** (sporicidal on clean surfaces; prepare fresh), **quaternary ammonium compounds** (routine surfaces).
- **Spill management:** pre-clean visible soil → apply appropriate **chlorine** solution with contact time → dispose per biomedical-waste rules.

---

5) OT sterilization & aseptic workflow (translate Suśruta's intent to modern theatre)

Zoning & air

- **Protective→Clean→Aseptic→Sterile zones** with **unidirectional flow** of people, instruments, and waste.
- **Air handling:** 15–20 air changes/hour, appropriate temperature/humidity; **HEPA** in critical areas.

Sets & packaging

- Instruments in **dedicated sets**, hinged instruments **opened**, heavy items placed low; sterilization pouches/cassettes **dated, labeled**; use **integrator strips** inside trays.

Indicators & release

- **Class 1** (process) outside every pack; **Class 5/6** inside representative packs; **BI** as per policy. Do **not** release implant loads until **BI** passes (unless policy allows quarantine release).

Aseptic conduct (team)

- OT attire, restricted traffic, **no jewelry**, mask over nose/mouth, controlled speaking; sterile field **only above waist and in front** of gowned/gloved team.

Classical support (fumigation/śodhana → modern parallels)

- Classical **dhūpana** (fumigation of spaces/wards) reflects the intent to maintain a **microbially hostile environment**; today we rely on **air handling + surface disinfection** and validated sterilization for instruments.
- Use Suśruta verse **Su.Su. 19/5** (Vraṇitāgāra) to introduce ward/OT environment answers; then finish with modern validation steps.

---

6) Aseptic techniques for the surgeon & team

Pre-op patient preparation

- Informed consent, site marking, **clipping (not shaving)**, pre-op bath if possible, **alcoholic chlorhexidine** skin prep (allow drying), sterile draping.

Surgical hand antisepsis (two acceptable methods)

A. Traditional scrub (antiseptic soap):

1. Remove jewelry; nails short.
2. Open sterile towel/gown pack.
3. **First scrub 3–5 minutes:** hands → forearms to elbow; **fingertips/nails first**; keep hands **above elbows**.
4. Rinse hands from fingertips to elbows so water flows off elbows.
5. Dry with sterile towel (one end per hand/forearm).

B. Alcohol-based handrub (ABHR) surgical prep:

1. Wash visibly soiled hands first, dry.
2. Apply **sufficient ABHR** to wet hands/forearms; rub following WHO 7-step pattern for **3 minutes total** (per product).
3. Let air-dry completely before gowning.

WHO 7-step hand-rub (exam diagram in words)

1. Palm to palm → 2) Right palm over left dorsum and vice versa → 3) Palm to palm fingers interlaced → 4) Backs of fingers to opposing palms → 5) Rotational rub of **thumbs** → 6) Rotational rub on **fingertips** in palm → 7) Wrists.

---

7) Donning the sterile gown and gloves (closed gloving method)

Donning the gown

1. Grasp folded gown inside surface; **let it unfold without shaking**.
2. Insert arms into sleeves; **keep hands inside cuffs** (for closed gloving).
3. Circulator ties at neck/back; maintain **sterile front from chest to table level**.

Closed gloving (preferred)

1. With right covered hand, pick up left glove by the folded cuff; place glove on left sleeve cuff **so glove opening aligns with sleeve opening**.
2. Hold glove cuff to the sleeve cuff; advance left hand into glove as you push left forearm forward—**hand stays inside gown sleeve until inside glove**.
3. Repeat for right hand.
4. Adjust without touching skin; tie waist belt using **sterile card**/hand-to-hand technique.

Open gloving (for procedures without gown or after glove change): open wrapper → glove the dominant hand first by gripping inner folded cuff → avoid touching glove **outer surface**.

Glove change (contamination): step back, announce contamination, remove glove safely, **handrub** (if open) or re-glove using **assisted** or **open** technique.

---

8) Instrument reprocessing: what students often miss (and examiners ask)

- **Point-of-use care:** wipe gross soil in OT, keep instruments **moist** (enzymatic foam).
- **Cleaning ≠ disinfection: soil blocks sterilant**; use **enzymatic detergents**, brushes; **ultrasonic bath** for box-locks/serrations; **flush lumens**.
- **Inspection:** check **hinges, serrations, tip alignment, insulation on electrosurgery**; discard/repair **damaged** items (prevents **Yantra-doṣa** effects like slippage/false passage).
- **Packaging:** indicators inside; heavy items low; avoid over-packing.
- **Storage:** cool, dry, covered; **first-in, first-out**; **event-related** sterility (not just date-related).
- **Traceability:** load number on pack; record **BI/CI** results; implant log.

---

9) Vraṇitāgāra → modern OT/ward check-list (ready to copy)

- **Space & orientation:** spacious bed/OT table with clearances; consistent orientation (cf. Su.Su. 19/5).
- **Light & air:** shadow-free lights; adequate air-changes; HEPA in critical zones.
- **Surfaces & flows:** seamless, cleanable surfaces; **dirty to dirty**, **clean to clean** flows; separate soiled utility.
- **Water & power:** uninterrupted; emergency backups.
- **Materials management:** sterile store separate; **quarantine area** for loads pending BI if policy.
- **Emergency set-ups:** suction tested; resuscitation trolley sealed and checked.
- **Biomedical waste:** color-coded bins; sharps safety; daily logs.
- **Dhūpana intent → modern practice:** maintain low bio-burden by validated **air + surface** protocols; no ad-hoc fumigation in place of validated processes.

---

10) Rapid revision table: choose the method

Item / Need	Preferred method	Alternatives / Notes
Steel instruments, textiles	**Steam (121–134 °C)**	Dry heat for some; avoid corrosion with proper wraps
Heat-sensitive lumened device	**ETO** / **Plasma (H_2O_2)**	Verify device IFU; ensure aeration after ETO
Liquids, heat-labile solutions	**0.22 µm filtration** (aseptic)	Do **not** autoclave if label forbids
Endoscopes	**HLD** (OPA/peracetic) in AER	Leak test, thorough rinse, dry & store
OT table/surfaces	**1% hypochlorite** / **QAC** / **70% alcohol**	Pre-clean visible soil first
Hands (routine)	**WHO hand-rub 7-steps**	Soap-water if visibly soiled
Surgical prep (hands)	**Surgical scrub 3–5 min** or **ABHR 3 min**	Dry completely before gloving

11) Assessment

A. MCQs (single best answer)

1. **Critical items** as per Spaulding classification must be:
   a) Washed only b) Low-level disinfected c) **Sterilized** d) Wiped with alcohol
   Ans: c
2. **Best method** for heat-stable steel instruments is:
   a) OPA HLD b) **Steam autoclave** c) ETO d) Filtration
   Ans: b
3. A flexible endoscope after cleaning usually requires:
   a) Dry heat b) **HLD** c) Radiation d) Filtration
   Ans: b
4. **Flash sterilization** (pre-vacuum 134–135 °C, 3–4 min) is reserved for:
   a) All routine loads b) Textiles c) **Unwrapped urgent items** d) Liquids
   Ans: c
5. Which statement about **ETO** is correct?
   a) Used for liquids b) **Requires aeration** c) For heat-stable only d) Never used for lumens
   Ans: b
6. **0.22 µm filtration** is used for:
   a) Metal instruments b) Textiles c) **Heat-labile solutions** d) Endoscope exteriors
   Ans: c
7. The **WHO hand-rub** sequence includes all **except**:
   a) Palm-to-palm b) Backs of fingers c) Thumbs d) **Elbow scrubbing**
   Ans: d
8. The śloka **Su.Su. 19/5** primarily supports:
   a) Choice of disinfectant b) **Ward/OT layout and preparedness** c) Antibiotic policy d) Biomedical waste color code
   Ans: b
9. **Biological indicator** organism for steam sterilizer:
   a) Bacillus atrophaeus b) **Geobacillus stearothermophilus** c) E. coli d) Candida albicans
   Ans: b
10. **Closed gloving** requires:
    a) Hands exposed from gown cuffs b) **Hands kept inside cuffs until inside glove** c) Non-sterile assistant d) Alcohol rub after gloving
    Ans: b

B. SAQs (3–5 lines each)

1. Define **Nirjantukaraṇa**. Classify sterilization methods with **two examples**.
2. Outline the **instrument reprocessing cycle** from point-of-use to storage.
3. Describe **Vraṇitāgāra** features using **Su.Su. 19/5** and give two modern design equivalents.
4. Write the **steps of closed gloving**.
5. Differentiate **sterilization vs HLD** with **two device examples**.

C. LAQs

1. **OT sterilization and aseptic workflow:** zoning, air handling, sets/packaging, indicators (CI/BI), release criteria, and documentation. Integrate how this fulfills the classical intent of a clean **Vraṇitāgāra** (quote **Su.Su. 19/5**).
2. **Hands-on techniques essay:** surgical hand antisepsis (soap vs ABHR), gowning (closed method), gloving (closed/open), and intra-op aseptic conduct. Add common errors and corrective steps.

---

13) Skill lab – Hands-on checklists (use in OSCE)

A) Surgical hand scrub (soap method, 3–5 minutes)

- Nails short, no jewelry → open packs → wet hands/forearms → **fingertips & nails first** → planes of hands → spaces between fingers → thumbs → forearms → rinse fingertips to elbows → dry with sterile towel (one end per limb).

B) ABHR surgical prep (3 minutes total contact)

- Clean/dry hands → apply enough product → **WHO 7-steps** (palms, dorsum, interlace, backs of fingers, thumbs, fingertips, wrists) → air-dry completely.

C) Gowning & closed gloving

- Gown on (hands inside cuffs) → glove positioned on cuff edge → advance hand into glove **without exposing skin** → repeat other hand → tie gown with sterile belt card.

Pro-tip for viva: Always phrase your choices with **item class (critical/semi-critical) → method → parameter → process control** (indicator/BI). Then, if asked about environment, quote **Su.Su. 19/5** and map to modern OT design.