C_U = nominal concentration of glucosamine in the *Sample solution* (mg/mL)
M_{r1} = molecular weight of glucosamine, 179.17
M_{r2} = molecular weight of glucosamine hydrochloride, 215.63

Acceptance criteria: 90.0%–120.0%

- **CONTENT OF CHONDROITIN SULFATE SODIUM**

Diluent: Weigh about 297 mg of monobasic potassium phosphate, 492 mg of dibasic potassium phosphate, and 250 mg of polysorbate 80, and transfer into a 1-L beaker. Dissolve in approximately 900 mL of water, and adjust with potassium hydroxide or phosphoric acid to a pH of 7.0 ± 0.2. Dilute with water to 1 L, and mix thoroughly.

Standard solutions: 1.5, 1.0, and 0.5 mg/mL of USP Chondroitin Sulfate Sodium RS in water

Sample solution: Transfer an equivalent to 100 mg of chondroitin sulfate sodium, from finely powdered Tablets (NLT 20), to 60 mL of water. Shake to suspend the powder in solution. Sonicate in a 65° water bath for 20 min. Remove from the bath, and stir or shake for 5 min. Dilute with water to 100 mL, and centrifuge or pass through a suitable filter.

Titrimetric system
(See *Titrimetry* ⟨541⟩.)
Mode: Photometric titration
Titrant: 1 mg/mL of cetylpyridinium chloride in water. Degas before use.
Endpoint detection: Turbidimetric with a photoelectric probe

Analysis
Samples: *Standard solutions* and *Sample solution*
Transfer 5.0 mL of each *Standard solution* and the *Sample solution* to separate titration vessels. Add 25 mL of *Diluent* to each. Stir until a steady reading is obtained with a photoelectric probe either at 420, 550, or 660 nm. Set the instrument to zero in absorbance mode. Titrate with *Titrant* using the photoelectric probe to determine the endpoint turbidimetrically. From a linear regression equation calculated using the volumes of *Titrant* consumed versus concentrations of the *Standard solutions*, determine the concentration of chondroitin sulfate sodium in the *Sample solution*.

Calculate the percentage of the labeled amount of chondroitin sulfate sodium in the portion of Tablets taken:

$$\text{Result} = (C/C_U) \times 100$$

C = determined concentration of chondroitin sulfate sodium in the *Sample solution* (mg/mL)
C_U = nominal concentration of chondroitin sulfate sodium in the *Sample solution* (mg/mL)

Acceptance criteria: 90.0%–120.0%

PERFORMANCE TESTS

- **DISINTEGRATION AND DISSOLUTION OF DIETARY SUPPLEMENTS ⟨2040⟩:** Meet the requirements for *Dissolution*

Medium: Water; 900 mL
Apparatus 2: 75 rpm
Time: 60 min

Determine the percentage of the labeled amount of glucosamine ($C_6H_{13}NO_5$) dissolved by using the following method.

Standard solution: Prepare as directed in the test for *Content of Glucosamine*. Dilute with a suitable quantity of water, if necessary.

Sample solution: Use the solution under test.

Borate buffer, Acetate buffer, Derivatizing reagent, Mobile phase, and **Chromatographic system:** Proceed as directed in the test for *Content of Glucosamine*.

Analysis: Proceed as directed in the test for *Content of Glucosamine*.

Calculate the percentage of the labeled amount of glucosamine ($C_6H_{13}NO_5$) dissolved:

$$\text{Result} = (r_U/r_S) \times (C_S \times V/L) \times (M_{r1}/M_{r2}) \times 100$$

r_U = peak area from the derivatized *Sample solution*
r_S = peak area from the derivatized *Standard solution*
C_S = concentration of USP Glucosamine Hydrochloride RS in the *Standard solution* (mg/mL)
V = volume of *Medium*, 900 mL
L = label claim of glucosamine (mg/Tablet)
M_{r1} = molecular weight of glucosamine, 179.17
M_{r2} = molecular weight of glucosamine hydrochloride, 215.63

Tolerances: NLT 75% of the labeled amount of glucosamine ($C_6H_{13}NO_5$) is dissolved.

Determine the percentage of the labeled amount of chondroitin sulfate sodium dissolved by using the following method.

Standard solutions, Titrant, and **Diluent:** Proceed as directed in the test for *Content of Chondroitin Sulfate Sodium*.

Sample solution: Use the solution under test.

Analysis: Proceed as directed in the test for *Content of Chondroitin Sulfate Sodium*.

Calculate the percentage of the labeled amount of chondroitin sulfate sodium dissolved:

$$\text{Result} = (C \times V/L) \times 100$$

C = determined concentration of chondroitin sulfate sodium in the *Sample solution* (mg/mL)
V = volume of *Medium*, 900 mL
L = label claim of chondroitin sulfate sodium (mg/Tablet)

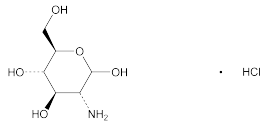
Tolerances: NLT 75% of the labeled amount of chondroitin sulfate sodium is dissolved.

- **WEIGHT VARIATION OF DIETARY SUPPLEMENTS ⟨2091⟩:** Meet the requirements

ADDITIONAL REQUIREMENTS

- **PACKAGING AND STORAGE:** Preserve in tight, light-resistant containers.
- **LABELING:** The label indicates the types of glucosamine salts contained in the article and the species source from which the chondroitin was derived. Label it to state the source(s) of chondroitin sulfate sodium, whether bovine, porcine, avian, or a mixture of any of them. The label states on the front panel the content of chondroitin sulfate sodium on the dried basis.
- **USP REFERENCE STANDARDS ⟨11⟩**
USP Chondroitin Sulfate Sodium RS
USP Glucosamine Hydrochloride RS

Glucosamine Hydrochloride



$C_6H_{13}NO_5 \cdot HCl$ 215.63
D-Glucose, 2-amino-2-deoxy-, hydrochloride;
2-Amino-2-deoxy-β-D-glucopyranose hydrochloride [66-84-2].

DEFINITION
Glucosamine Hydrochloride contains NLT 98.0% and NMT 102.0% of glucosamine hydrochloride ($C_6H_{13}NO_5 \cdot HCl$), calculated on the dried basis.

IDENTIFICATION
- **A. INFRARED ABSORPTION** ⟨**197K**⟩
- **B. IDENTIFICATION TESTS—GENERAL,** *Chloride* ⟨**191**⟩**:** Meets the requirements
- **C.** The retention time of the glucosamine peak of the *Sample solution* corresponds to that of the *Standard solution*, as obtained in the *Assay*.

ASSAY
- **PROCEDURE**

Buffer: In a 1-L volumetric flask, dissolve 3.5 g of dibasic potassium phosphate in water. Add 0.25 mL of ammonium hydroxide, dilute with water to volume, and mix. Adjust with phosphoric acid to a pH of 7.5.
Mobile phase: Acetonitrile and *Buffer* (75:25)
Diluent: Acetonitrile and water (50:50)
Standard solution: 3.8 mg/mL of USP Glucosamine Hydrochloride RS in *Diluent*
Sample solution: 3.8 mg/mL of Glucosamine Hydrochloride in *Diluent*. [NOTE—Shake by mechanical means to aid dissolution.]
Chromatographic system
(See *Chromatography* ⟨621⟩*, System Suitability*.)
Mode: LC
Detector: UV 195 nm
Column: 4.6-mm × 15-cm; 5-µm packing L8
Column temperature: 35°
Flow rate: 1.5 mL/min
Injection size: 10 µL
System suitability
Sample: *Standard solution*
[NOTE—The peak for the glucosamine moiety elutes at about 10 min. The chromatogram shows a large additional peak near the void volume, due to the chloride ion.]
Suitability requirements
Tailing factor: NMT 2.0 for the glucosamine peak
Efficiency: NLT 1500 theoretical plates
Relative standard deviation: NMT 2.0%
Analysis
Samples: *Standard solution* and *Sample solution*
Calculate the percentage of glucosamine hydrochloride ($C_6H_{13}NO_5 \cdot HCl$) in the portion of Glucosamine Hydrochloride taken:

$$\text{Result} = (r_U/r_S) \times (C_S/C_U) \times 100$$

r_U = peak response from the *Sample solution*
r_S = peak response from the *Standard solution*
C_S = concentration of USP Glucosamine Hydrochloride RS in the *Standard solution* (mg/mL)
C_U = concentration of Glucosamine Hydrochloride in the *Sample solution* (mg/mL)
Acceptance criteria: 98.0%–102.0% on the dried basis

IMPURITIES
- **RESIDUE ON IGNITION** ⟨**281**⟩**:** NMT 0.1%
- **CHLORIDE AND SULFATE,** *Sulfate* ⟨**221**⟩**:** A 0.10-g portion shows no more sulfate than corresponds to 0.25 mL of 0.020 N sulfuric acid (NMT 0.24%).
- **ARSENIC,** *Method II* ⟨**211**⟩**:** NMT 3 ppm
- **HEAVY METALS,** *Method II* ⟨**231**⟩**:** NMT 10 ppm

SPECIFIC TESTS
- **OPTICAL ROTATION,** *Specific Rotation* ⟨**781S**⟩**:** +70.0° to +73.0°

Sample solution: 25 mg/mL. Measure the specific rotation 3 h after preparation.
- **pH** ⟨**791**⟩

Sample solution: 20 mg/mL
Acceptance criteria: 3.0–5.0
- **LOSS ON DRYING** ⟨**731**⟩**:** Dry a sample at 105° for 2 h: it loses NMT 1.0% of its weight.

ADDITIONAL REQUIREMENTS
- **PACKAGING AND STORAGE:** Preserve in tight, light-resistant containers.
- **USP REFERENCE STANDARDS** ⟨**11**⟩

USP Glucosamine Hydrochloride RS

Glucosamine Tablets

DEFINITION
Glucosamine Tablets are prepared from Glucosamine Hydrochloride, Glucosamine Sulfate Sodium Chloride, Glucosamine Sulfate Potassium Chloride, or a mixture of any of them. Tablets contain NLT 90.0% and NMT 110.0% of the labeled amount of glucosamine ($C_6H_{13}NO_5$).

IDENTIFICATION
- **A.** The retention time of the major peak of the *Sample solution* corresponds to that of the *Standard solution,* as obtained in the test for *Content of Glucosamine.*
- **B. IDENTIFICATION TESTS—GENERAL,** *Chloride* ⟨**191**⟩**:** Meets the requirements
- **C. IDENTIFICATION TESTS—GENERAL,** *Sulfate* ⟨**191**⟩**:** Meets the requirements. [NOTE—Only for Tablets labeled as containing glucosamine sodium sulfate or glucosamine potassium sulfate]

STRENGTH
- **CONTENT OF GLUCOSAMINE**

Buffer: In a 1-L volumetric flask dissolve 3.5 g of dibasic potassium phosphate in water. Add 0.25 mL of ammonium hydroxide, dilute with water to volume, and mix. Adjust with phosphoric acid to a pH of 7.5.
Mobile phase: Acetonitrile and *Buffer* (75:25)
Diluent: Acetonitrile and water (50:50)
Standard solution: 3.75 mg/mL of USP Glucosamine Hydrochloride RS in *Diluent*
Sample solution: Weigh and finely powder NLT 20 Tablets. Transfer an accurately weighed portion of the finely powdered material, equivalent to about 312 mg of glucosamine, to a 100-mL volumetric flask. Add 60 mL of *Diluent*, and sonicate for 10 min. Shake by mechanical means for 15 min. Dilute with *Diluent* to volume, and mix. Pass a portion of this solution through a membrane filter of 0.45-µm or finer pore size.
Chromatographic system
(See *Chromatography* ⟨621⟩*, System Suitability*.)
Mode: LC
Detector: UV 195 nm
Column: 4.6-mm × 15-cm; 5-µm packing L8
Column temperature: 35°
Flow rate: 1.5 mL/min
Injection size: 10 µL
[NOTE—The peak for glucosamine moiety elutes at about 10 min. The chromatogram shows a large additional peak near the void volume, due to the chloride ion.]