

A(N) _____ IS A HYDROCARBON IN WHICH ONE OR MORE HYDROGEN ATOMS IS REPLACED BY A -COOH AND A -NH₂ GROUP.

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UNDERSTANDING THE CONCEPT OF FUNCTIONALIZED HYDROCARBONS

WHEN EXPLORING ORGANIC CHEMISTRY AND THE VAST DIVERSITY OF HYDROCARBONS, ONE ENCOUNTERS VARIOUS DERIVATIVES THAT POSSESS UNIQUE PROPERTIES AND REACTIVITIES. AMONG THESE DERIVATIVES, COMPOUNDS THAT INCORPORATE SPECIFIC FUNCTIONAL GROUPS SUCH AS -COOH (CARBOXYL GROUP) AND -NH₂ (AMINO GROUP) ARE OF PARTICULAR INTEREST DUE TO THEIR BIOLOGICAL SIGNIFICANCE AND INDUSTRIAL APPLICATIONS. THE STATEMENT, "A(N) _____ IS A HYDROCARBON IN WHICH ONE OR MORE HYDROGEN ATOMS IS REPLACED BY A -COOH AND A -NH₂ GROUP," HINTS AT A CLASS OF MOLECULES THAT ARE FUNDAMENTAL IN BIOCHEMISTRY AND ORGANIC SYNTHESIS.

DEFINING THE TERM: THE MISSING WORD

BEFORE DELVING INTO DETAILED EXPLANATIONS, IT'S ESSENTIAL TO IDENTIFY THE TERM THAT FILLS THE BLANK. THE CORRECT TERM IS "AMINO ACID."

A(N) AMINO ACID IS A HYDROCARBON IN WHICH ONE OR MORE HYDROGEN ATOMS IS REPLACED BY A -COOH AND A -NH₂ GROUP.

THIS DEFINITION, WHILE SIMPLIFIED, CAPTURES THE ESSENCE OF AMINO ACIDS, WHICH ARE ORGANIC MOLECULES CHARACTERIZED BY THE PRESENCE OF BOTH AMINO (-NH₂) AND CARBOXYL (-COOH) FUNCTIONAL GROUPS ATTACHED TO A CENTRAL CARBON ATOM.

WHAT ARE AMINO ACIDS?

AMINO ACIDS ARE ORGANIC COMPOUNDS THAT SERVE AS THE BUILDING BLOCKS OF PROTEINS. THEY ARE VITAL FOR NUMEROUS BIOLOGICAL PROCESSES, INCLUDING ENZYME FUNCTION, CELL SIGNALING, AND STRUCTURAL COMPONENTS OF TISSUES.

KEY CHARACTERISTICS OF AMINO ACIDS

- CONTAIN AT LEAST ONE AMINO GROUP (-NH₂)
- CONTAIN AT LEAST ONE CARBOXYL GROUP (-COOH)
- HAVE A CENTRAL (A) CARBON ATOM
- POSSESS A VARIABLE SIDE CHAIN (R GROUP) THAT DETERMINES THE SPECIFIC AMINO ACID

- EXIST PREDOMINANTLY IN THE L-CONFIGURATION IN BIOLOGICAL SYSTEMS

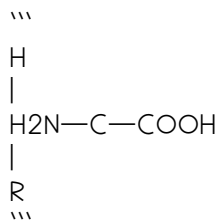
STRUCTURAL COMPOSITION OF AMINO ACIDS

THE TYPICAL STRUCTURE OF AN AMINO ACID CAN BE SUMMARIZED AS FOLLOWS:

CENTRAL FEATURES

1. **ALPHA CARBON (C_α):** THE CENTRAL CARBON ATOM TO WHICH ALL OTHER GROUPS ARE ATTACHED.
2. **AMINO GROUP (-NH₂):** PROVIDES BASIC PROPERTIES AND PARTICIPATES IN PEPTIDE BOND FORMATION.
3. **CARBOXYL GROUP (-COOH):** ACTS AS AN ACID, DONATING A PROTON IN BIOCHEMICAL REACTIONS.
4. **HYDROGEN ATOM (-H):** ATTACHED TO THE ALPHA CARBON.
5. **SIDE CHAIN (R GROUP):** VARIES AMONG AMINO ACIDS, CONFERRING UNIQUE PROPERTIES.

DIAGRAM OF A GENERAL AMINO ACID:



CLASSIFICATION OF AMINO ACIDS

AMINO ACIDS CAN BE CLASSIFIED BASED ON THE NATURE OF THEIR SIDE CHAINS:

1. BASED ON POLARITY

- **NONPOLAR (HYDROPHOBIC):** E.G., GLYCINE, VALINE, LEUCINE
- **POLAR (HYDROPHILIC):** E.G., SERINE, THREONINE, ASPARAGINE
- **CHARGED:**
 - **ACIDIC:** ASPARTIC ACID, GLUTAMIC ACID

- **BASIC:** LYSINE, ARGININE, HISTIDINE

2. BASED ON ESSENTIALITY

- **ESSENTIAL AMINO ACIDS:** CANNOT BE SYNTHESIZED BY THE HUMAN BODY; MUST BE OBTAINED FROM DIET.
- **NON-ESSENTIAL AMINO ACIDS:** CAN BE SYNTHESIZED INTERNALLY.

BIOLOGICAL SIGNIFICANCE OF AMINO ACIDS

AMINO ACIDS ARE MORE THAN JUST THE MONOMERS OF PROTEINS; THEY ARE INVOLVED IN VARIOUS METABOLIC PATHWAYS, SIGNALING, AND CELLULAR FUNCTIONS.

ROLES IN THE BODY

- BUILDING BLOCKS FOR PROTEIN SYNTHESIS
- PRECURSORS FOR NEUROTRANSMITTERS (E.G., TRYPTOPHAN FOR SEROTONIN)
- PARTICIPANTS IN ENERGY PRODUCTION
- INVOLVED IN IMMUNE RESPONSES
- CONTRIBUTORS TO METABOLIC REGULATION

EXAMPLES OF IMPORTANT AMINO ACIDS

1. GLYCINE
2. ALANINE
3. VALINE
4. LEUCINE
5. SERINE
6. PHENYLALANINE

7. LYSINE

MANUFACTURE AND EXTRACTION OF AMINO ACIDS

AMINO ACIDS ARE OBTAINED THROUGH VARIOUS METHODS DEPENDING ON THEIR SOURCE.

NATURAL SOURCES

- PROTEINS FROM PLANT AND ANIMAL TISSUES
- FERMENTATION PROCESSES USING BACTERIA AND FUNGI

SYNTHETIC PRODUCTION

1. CHEMICAL SYNTHESIS: USING METHODS LIKE STRECKER SYNTHESIS
2. BIOTECHNOLOGICAL METHODS: MICROBIAL FERMENTATION FOR LARGE-SCALE PRODUCTION

APPLICATIONS OF AMINO ACIDS IN INDUSTRY AND MEDICINE

AMINO ACIDS HAVE A WIDE RANGE OF APPLICATIONS BEYOND BIOLOGICAL SYSTEMS.

INDUSTRIAL USES

- FOOD ADDITIVES AND FLAVOR ENHANCERS (E.G., MONOSODIUM GLUTAMATE)
- SUPPLEMENTS FOR ATHLETES AND BODYBUILDERS
- PHARMACEUTICAL MANUFACTURING (E.G., AMINO ACID-BASED DRUGS)
- COSMETICS AND SKINCARE PRODUCTS

MEDICAL USES

- TREATMENT OF AMINO ACID DEFICIENCIES
- SUPPORT IN PARENTERAL NUTRITION
- RESEARCH TOOLS IN BIOCHEMISTRY AND MOLECULAR BIOLOGY

SUMMARY AND KEY TAKEAWAYS

- THE TERM THAT FITS THE BLANK IS "AMINO ACID."
- AMINO ACIDS ARE ORGANIC MOLECULES FEATURING BOTH AMINO (-NH_2) AND CARBOXYL (-COOH) GROUPS ATTACHED TO A CENTRAL CARBON.
- THEY ARE ESSENTIAL FOR PROTEIN SYNTHESIS, METABOLIC FUNCTIONS, AND ACT AS PRECURSORS FOR MANY BIOMOLECULES.
- THE DIVERSITY AMONG AMINO ACIDS IS PRIMARILY DUE TO THEIR SIDE CHAINS, WHICH INFLUENCE THEIR PROPERTIES AND FUNCTIONS.
- THEY ARE PRODUCED BOTH NATURALLY AND SYNTHETICALLY, SERVING NUMEROUS INDUSTRIAL AND MEDICAL PURPOSES.

CONCLUSION

UNDERSTANDING AMINO ACIDS IS FUNDAMENTAL TO GRASPING THE COMPLEXITIES OF BIOCHEMISTRY AND ORGANIC CHEMISTRY. THEIR UNIQUE STRUCTURE, COMBINING HYDROCARBON FRAMEWORKS WITH FUNCTIONAL GROUPS LIKE -COOH AND -NH_2 , MAKES THEM VERSATILE AND VITAL COMPOUNDS. WHETHER IN THE CONTEXT OF NUTRITION, MEDICINE, OR INDUSTRIAL APPLICATIONS, AMINO ACIDS EXEMPLIFY THE ELEGANCE OF ORGANIC MOLECULES DESIGNED BY NATURE TO SUPPORT LIFE AT THE MOLECULAR LEVEL. RECOGNIZING THEIR STRUCTURE AND FUNCTION PROVIDES INSIGHT INTO THE MOLECULAR ARCHITECTURE OF LIVING ORGANISMS AND THE POTENTIAL FOR BIOTECHNOLOGICAL INNOVATION.

META DESCRIPTION:

DISCOVER WHAT AN AMINO ACID IS—A HYDROCARBON MOLECULE WHERE ONE OR MORE HYDROGEN ATOMS ARE REPLACED BY A -COOH (CARBOXYL) AND A -NH_2 (AMINO) GROUP. EXPLORE THEIR STRUCTURE, CLASSIFICATION, SIGNIFICANCE, AND APPLICATIONS IN SCIENCE AND INDUSTRY.

FREQUENTLY ASKED QUESTIONS

WHAT IS A HYDROCARBON WHERE ONE OR MORE HYDROGEN ATOMS ARE REPLACED BY -COOH AND -NH_2 GROUPS CALLED?

SUCH A HYDROCARBON IS CALLED AN AMINO ACID.

HOW DOES THE PRESENCE OF -COOH AND -NH₂ GROUPS DEFINE AN AMINO ACID'S STRUCTURE?

THE -COOH (CARBOXYL) AND -NH₂ (AMINO) GROUPS ATTACHED TO THE HYDROCARBON BACKBONE CHARACTERIZE AMINO ACIDS, MAKING THEM ESSENTIAL BUILDING BLOCKS OF PROTEINS.

ARE AMINO ACIDS CONSIDERED HYDROCARBONS, AND WHY?

WHILE AMINO ACIDS CONTAIN HYDROCARBON CHAINS, THEY ARE CLASSIFIED AS ORGANIC COMPOUNDS WITH FUNCTIONAL GROUPS (-COOH AND -NH₂), MAKING THEM AMINO ACIDS RATHER THAN SIMPLE HYDROCARBONS.

WHAT ROLE DO THE -COOH AND -NH₂ GROUPS PLAY IN AMINO ACIDS' CHEMICAL PROPERTIES?

THE -COOH GROUP IMPARTS ACIDITY, AND THE -NH₂ GROUP IMPARTS BASICITY, ALLOWING AMINO ACIDS TO ACT AS BOTH ACIDS AND BASES IN BIOLOGICAL SYSTEMS.

IS AN AMINO ACID A SIMPLE HYDROCARBON? WHY OR WHY NOT?

NO, BECAUSE IT CONTAINS ADDITIONAL FUNCTIONAL GROUPS (-COOH AND -NH₂) THAT GIVE IT UNIQUE CHEMICAL PROPERTIES BEYOND THOSE OF A SIMPLE HYDROCARBON.

CAN AMINO ACIDS BE CONSIDERED DERIVATIVES OF HYDROCARBONS?

YES, AMINO ACIDS ARE DERIVATIVES OF HYDROCARBONS WITH FUNCTIONAL GROUPS ATTACHED, MAKING THEM MORE COMPLEX ORGANIC COMPOUNDS.

WHAT IS THE SIGNIFICANCE OF REPLACING HYDROGEN ATOMS WITH -COOH AND -NH₂ GROUPS IN HYDROCARBONS?

THIS REPLACEMENT TRANSFORMS HYDROCARBONS INTO AMINO ACIDS, WHICH ARE VITAL FOR BIOLOGICAL FUNCTIONS LIKE PROTEIN SYNTHESIS AND METABOLIC PROCESSES.

ADDITIONAL RESOURCES

A(N) _____ IS A HYDROCARBON IN WHICH ONE OR MORE HYDROGEN ATOMS IS REPLACED BY A -COOH AND A -NH₂ GROUP.

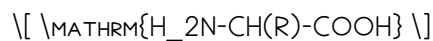
UNDERSTANDING THE INTRICATE WORLD OF ORGANIC CHEMISTRY OFTEN INVOLVES DELVING INTO VARIOUS CLASSES OF COMPOUNDS, EACH WITH UNIQUE STRUCTURES AND PROPERTIES. AMONG THESE, COMPOUNDS CHARACTERIZED BY SPECIFIC FUNCTIONAL GROUPS PLAY A CRUCIAL ROLE IN BIOLOGICAL SYSTEMS, INDUSTRIAL APPLICATIONS, AND SYNTHETIC CHEMISTRY. THE DESCRIPTION PROVIDED POINTS TOWARD A CLASS OF MOLECULES THAT ARE HYDROCARBONS BUT HAVE UNDERGONE SUBSTITUTION WITH BOTH CARBOXYL (-COOH) AND AMINO (-NH₂) GROUPS. THESE COMPOUNDS ARE COMMONLY KNOWN AS AMINO ACIDS, WHICH ARE FUNDAMENTAL TO LIFE ITSELF. THIS REVIEW AIMS TO EXPLORE THESE COMPOUNDS IN DETAIL, COVERING THEIR STRUCTURE, CLASSIFICATION, PROPERTIES, SIGNIFICANCE, AND APPLICATIONS.

DEFINING THE COMPOUND: WHAT IS AN AMINO ACID?

THE BLANK IN THE INITIAL STATEMENT, "A(N) _____ IS A HYDROCARBON IN WHICH ONE OR MORE HYDROGEN ATOMS ARE

REPLACED BY A -COOH AND A -NH₂ GROUP," IS MOST ACCURATELY FILLED WITH THE TERM "AMINO ACID."

AN AMINO ACID IS AN ORGANIC COMPOUND CONTAINING BOTH AN AMINO GROUP (-NH₂) AND A CARBOXYL GROUP (-COOH) ATTACHED TO A CENTRAL CARBON ATOM, KNOWN AS THE ALPHA CARBON. THIS STRUCTURE MAKES AMINO ACIDS THE BUILDING BLOCKS OF PROTEINS AND ESSENTIAL MOLECULES IN ALL LIVING ORGANISMS. THE GENERAL FORMULA OF A TYPICAL AMINO ACID IS:



WHERE R REPRESENTS A VARIABLE SIDE CHAIN THAT DETERMINES THE SPECIFIC PROPERTIES AND IDENTITY OF EACH AMINO ACID.

KEY FEATURES OF AMINO ACIDS INCLUDE:

- THE PRESENCE OF BOTH ACIDIC (-COOH) AND BASIC (-NH₂) FUNCTIONAL GROUPS, MAKING THEM AMPHOTERIC.
- THE CHIRAL NATURE OF MOST AMINO ACIDS (EXCEPT GLYCINE), WHICH ALLOWS FOR STEREOISOMERISM.
- THEIR ABILITY TO PARTICIPATE IN PEPTIDE BOND FORMATION, LEADING TO PROTEINS.

STRUCTURAL OVERVIEW OF AMINO ACIDS

CORE STRUCTURE

AMINO ACIDS CONSIST OF A CENTRAL ALPHA CARBON (C_α) BONDED TO FOUR DIFFERENT GROUPS:

- AN AMINO GROUP (-NH₂)
- A CARBOXYL GROUP (-COOH)
- A HYDROGEN ATOM (-H)
- A VARIABLE SIDE CHAIN (R GROUP)

THIS TETRAHEDRAL ARRANGEMENT RESULTS IN CHIRALITY FOR MOST AMINO ACIDS, EXCEPT GLYCINE, WHERE R IS A HYDROGEN.

VARIABILITY OF R GROUPS

THE SIDE CHAIN (R GROUP) VARIES AMONG DIFFERENT AMINO ACIDS, CONFERRING UNIQUE CHEMICAL AND PHYSICAL PROPERTIES:

- NONPOLAR, HYDROPHOBIC SIDE CHAINS (E.G., LEUCINE, VALINE)
- POLAR, UNCHARGED SIDE CHAINS (E.G., SERINE, THREONINE)
- ACIDIC OR BASIC SIDE CHAINS (E.G., ASPARTIC ACID, LYSINE)
- AROMATIC SIDE CHAINS (E.G., PHENYLALANINE, TRYPTOPHAN)

CLASSIFICATION OF AMINO ACIDS

AMINO ACIDS ARE TRADITIONALLY CLASSIFIED BASED ON THEIR SIDE CHAIN PROPERTIES:

ESSENTIAL VS. NON-ESSENTIAL

- ESSENTIAL AMINO ACIDS: CANNOT BE SYNTHESIZED BY THE HUMAN BODY; MUST BE OBTAINED THROUGH DIET (E.G., LEUCINE, LYSINE, METHIONINE).

- NON-ESSENTIAL AMINO ACIDS: CAN BE PRODUCED ENDOGENOUSLY (E.G., ALANINE, GLUTAMINE).

BASED ON POLARITIES

- HYDROPHOBIC (NONPOLAR): TEND TO BE FOUND IN THE INTERIOR OF PROTEIN STRUCTURES.
- HYDROPHILIC (POLAR): USUALLY LOCATED ON THE EXTERIOR, INTERACTING WITH AQUEOUS ENVIRONMENTS.
- CHARGED (ACIDIC OR BASIC): PLAY ROLES IN ENZYME ACTIVITY AND CELL SIGNALING.

BASED ON SIDE CHAIN FUNCTIONALITIES

- ACIDIC AMINO ACIDS: CONTAIN CARBOXYL GROUPS IN THEIR SIDE CHAINS (E.G., ASPARTIC ACID, GLUTAMIC ACID).
- BASIC AMINO ACIDS: CONTAIN AMINO GROUPS IN THEIR SIDE CHAINS (E.G., LYSINE, ARGININE).

PROPERTIES OF AMINO ACIDS

UNDERSTANDING THE PROPERTIES OF AMINO ACIDS IS VITAL FOR THEIR ROLES IN BIOLOGICAL SYSTEMS AND SYNTHETIC APPLICATIONS.

PHYSICAL PROPERTIES

- SOLUBILITY: MOST AMINO ACIDS ARE SOLUBLE IN WATER DUE TO THEIR POLAR GROUPS.
- MELTING POINTS: GENERALLY HIGH BECAUSE OF THEIR ABILITY TO FORM HYDROGEN BONDS.
- OPTICAL ACTIVITY: DUE TO CHIRALITY, MANY AMINO ACIDS ARE OPTICALLY ACTIVE, ROTATING PLANE-POLARIZED LIGHT.

CHEMICAL PROPERTIES

- ACID-BASE BEHAVIOR: AMPHOTERIC NATURE ALLOWS AMINO ACIDS TO ACT AS BOTH ACIDS AND BASES.
- ZWITTERION FORMATION: AT PHYSIOLOGICAL pH (~ 7.4), AMINO ACIDS EXIST AS ZWITTERIONS, WITH A POSITIVELY CHARGED AMINO GROUP AND A NEGATIVELY CHARGED CARBOXYL GROUP.
- REACTIVITY: THE AMINO AND CARBOXYL GROUPS CAN PARTICIPATE IN PEPTIDE BOND FORMATION AND OTHER CHEMICAL REACTIONS.

BIOLOGICAL SIGNIFICANCE OF AMINO ACIDS

AMINO ACIDS ARE INDISPENSABLE IN LIFE SCIENCES DUE TO THEIR ROLES:

- PROTEIN SYNTHESIS: THEY ARE THE MONOMERS OF PROTEINS, FORMING PEPTIDE BONDS TO CREATE POLYPEPTIDES WITH DIVERSE FUNCTIONS.
- METABOLIC INTERMEDIATES: SOME AMINO ACIDS SERVE AS PRECURSORS TO NEUROTRANSMITTERS, HORMONES, AND OTHER BIOMOLECULES.
- ENERGY SOURCES: IN TIMES OF NUTRITIONAL DEFICIENCY, AMINO ACIDS CAN BE CATABOLIZED FOR ENERGY.

ESSENTIAL ROLE IN HUMAN NUTRITION

AMINO ACIDS ARE OBTAINED THROUGH DIET, ESPECIALLY THE ESSENTIAL ONES, HIGHLIGHTING THEIR IMPORTANCE IN NUTRITION AND HEALTH.

ROLE IN DISEASE AND MEDICINE

ALTERATIONS IN AMINO ACID METABOLISM ARE LINKED TO VARIOUS DISEASES, INCLUDING PHENYLKETONURIA AND MAPLE SYRUP URINE DISEASE. THEY ARE ALSO USED THERAPEUTICALLY IN AMINO ACID SUPPLEMENTATION.

APPLICATIONS OF AMINO ACIDS

BEYOND THEIR BIOLOGICAL ROLES, AMINO ACIDS HAVE NUMEROUS INDUSTRIAL AND RESEARCH APPLICATIONS.

FOOD INDUSTRY

- USED AS FLAVOR ENHANCERS (E.G., GLUTAMIC ACID IN MSG).
- EMPLOYED IN NUTRITIONAL SUPPLEMENTS FOR ATHLETES AND PATIENTS.

PHARMACEUTICALS

- USED IN THE SYNTHESIS OF DRUGS AND AS PRECURSORS FOR PHARMACEUTICALS.
- EMPLOYED IN PARENTERAL NUTRITION FORMULATIONS.

RESEARCH AND BIOTECHNOLOGY

- AMINO ACIDS ARE ESSENTIAL IN PROTEIN ENGINEERING AND SYNTHETIC BIOLOGY.
- USED AS BUILDING BLOCKS IN PEPTIDE SYNTHESIS.

COSMETICS AND PERSONAL CARE

- INCORPORATED INTO SKINCARE PRODUCTS FOR THEIR MOISTURIZING PROPERTIES.

ADVANTAGES AND DISADVANTAGES OF AMINO ACIDS

WHILE AMINO ACIDS ARE INVALUABLE, THEIR USE AND PROPERTIES COME WITH CONSIDERATIONS:

PROS:

- ESSENTIAL FOR LIFE PROCESSES AND HEALTH.
- VERSATILE IN SYNTHETIC APPLICATIONS.
- RICH DIVERSITY DUE TO VARIABLE R GROUPS.
- BIOCOMPATIBLE AND BIODEGRADABLE.

CONS:

- SOME AMINO ACIDS CAN BE TOXIC IN EXCESS (E.G., HIGH LEVELS OF PHENYLALANINE IN PHENYLKETONURIA).

- SYNTHESIS AND PURIFICATION CAN BE COMPLEX AND COSTLY.
- IMBALANCE IN AMINO ACID INTAKE CAN CAUSE METABOLIC DISORDERS.

CONCLUSION

AMINO ACIDS, THE FUNDAMENTAL UNITS OF PROTEINS, ARE A FASCINATING CLASS OF COMPOUNDS CHARACTERIZED BY THEIR UNIQUE STRUCTURE FEATURING BOTH -COOH AND -NH_2 GROUPS ATTACHED TO A CENTRAL CARBON. THEIR CHEMICAL VERSATILITY, BIOLOGICAL IMPORTANCE, AND WIDE-RANGING APPLICATIONS MAKE THEM CENTRAL TO FIELDS SPANNING FROM BIOCHEMISTRY TO INDUSTRIAL MANUFACTURING. UNDERSTANDING THEIR PROPERTIES AND FUNCTIONS NOT ONLY ENHANCES OUR KNOWLEDGE OF BIOLOGICAL SYSTEMS BUT ALSO OPENS AVENUES FOR INNOVATIVE APPLICATIONS IN MEDICINE, NUTRITION, AND BIOTECHNOLOGY. AS RESEARCH ADVANCES, NEW AMINO ACID DERIVATIVES AND SYNTHETIC METHODS CONTINUE TO EXPAND THE HORIZONS OF THIS VITAL CLASS OF COMPOUNDS, UNDERSCORING THEIR ENDURING SIGNIFICANCE IN SCIENCE AND INDUSTRY.

A N Is A Hydrocarbon In Which One Or More Hydrogen Atoms Is Replaced By A Cooh And A Nh2 Group

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