

FREE MARTIN HEIFER PENCIL TEST

FREE MARTIN HEIFER PENCIL TEST IS A CRUCIAL DIAGNOSTIC TOOL USED IN CATTLE BREEDING TO DETERMINE THE SEX AND REPRODUCTIVE STATUS OF CALVES, PARTICULARLY IN IDENTIFYING FREEMARTIN HEIFERS. THIS TEST PLAYS A SIGNIFICANT ROLE IN MANAGING CATTLE HERDS EFFICIENTLY BY DISTINGUISHING BETWEEN FERTILE FEMALES AND STERILE FREEMARTINS, WHICH ARE TYPICALLY FEMALE CALVES BORN AS TWINS WITH A MALE COUNTERPART. UNDERSTANDING THE NUANCES OF THE FREE MARTIN HEIFER PENCIL TEST CAN HELP FARMERS AND VETERINARIANS OPTIMIZE BREEDING PROGRAMS, REDUCE ECONOMIC LOSSES, AND IMPROVE HERD PRODUCTIVITY. THIS ARTICLE WILL EXPLORE THE SCIENCE BEHIND THE FREEMARTIN CONDITION, THE METHODOLOGY OF THE PENCIL TEST, ITS INTERPRETATION, AND PRACTICAL APPLICATIONS IN CATTLE MANAGEMENT. ADDITIONALLY, IT WILL ADDRESS COMMON CHALLENGES AND ALTERNATIVE DIAGNOSTIC METHODS FOR IDENTIFYING FREEMARTINS. THE FOLLOWING SECTIONS PROVIDE A COMPREHENSIVE OVERVIEW OF THESE TOPICS TO EQUIP READERS WITH DETAILED KNOWLEDGE ABOUT THE FREE MARTIN HEIFER PENCIL TEST.

- UNDERSTANDING FREEMARTINISM IN CATTLE
- THE FREE MARTIN HEIFER PENCIL TEST EXPLAINED
- PROCEDURE AND INTERPRETATION OF THE PENCIL TEST
- BENEFITS AND LIMITATIONS OF THE PENCIL TEST
- ALTERNATIVE METHODS FOR FREEMARTIN DIAGNOSIS
- PRACTICAL APPLICATIONS IN CATTLE BREEDING MANAGEMENT

UNDERSTANDING FREEMARTINISM IN CATTLE

FREEMARTINISM IS A CONDITION PRIMARILY FOUND IN CATTLE WHERE A FEMALE CALF IS BORN STERILE DUE TO THE INFLUENCE OF HER MALE TWIN. THIS OCCURS WHEN A FEMALE (HEIFER) AND A MALE (BULL) TWIN SHARE PLACENTAL BLOOD CIRCULATION, LEADING TO THE EXCHANGE OF CELLS AND HORMONES. THE MALE HORMONES INHIBIT THE DEVELOPMENT OF THE FEMALE REPRODUCTIVE TRACT, RESULTING IN A STERILE HEIFER KNOWN AS A FREEMARTIN. RECOGNIZING FREEMARTINS EARLY IS CRITICAL FOR EFFECTIVE HERD MANAGEMENT TO AVOID BREEDING STERILE ANIMALS.

CAUSES OF FREEMARTINISM

THE PRIMARY CAUSE OF FREEMARTINISM IS THE SHARED VASCULAR CONNECTION BETWEEN MALE AND FEMALE TWINS IN UTERO. THIS PLACENTAL ANASTOMOSIS ALLOWS MASCULINIZING HORMONES, SUCH AS TESTOSTERONE AND ANTI-M_{LLERIAN} HORMONE, TO AFFECT THE FEMALE TWIN'S REPRODUCTIVE ORGAN DEVELOPMENT. AS A RESULT, THE FREEMARTIN HEIFER TYPICALLY HAS UNDERDEVELOPED OVARIES, AN INCOMPLETELY FORMED UTERUS, AND SOMETIMES AMBIGUOUS EXTERNAL GENITALIA. THIS HORMONAL INFLUENCE IS IRREVERSIBLE AND LEADS TO PERMANENT INFERTILITY.

IDENTIFICATION AND IMPORTANCE

IDENTIFYING FREEMARTINS SOON AFTER BIRTH IS ESSENTIAL BECAUSE THESE HEIFERS CANNOT CONCEIVE OR CARRY PREGNANCIES. VISUALLY, FREEMARTINS MAY APPEAR NORMAL BUT OFTEN DISPLAY SUBTLE ANATOMICAL DIFFERENCES. WITHOUT ACCURATE TESTING SUCH AS THE FREE MARTIN HEIFER PENCIL TEST, FARMERS MAY MISTAKENLY RETAIN STERILE FEMALES IN THE BREEDING HERD, LEADING TO ECONOMIC LOSS AND INEFFICIENCIES. EARLY DIAGNOSIS ENABLES TIMELY CULLING OR ALTERNATIVE USE OF THESE ANIMALS.

THE FREE MARTIN HEIFER PENCIL TEST EXPLAINED

THE FREE MARTIN HEIFER PENCIL TEST IS A SIMPLE, COST-EFFECTIVE DIAGNOSTIC TECHNIQUE USED TO DIFFERENTIATE BETWEEN FERTILE HEIFERS AND FREEMARTINS. THIS TEST ASSESSES THE PRESENCE AND CHARACTERISTICS OF THE VAGINAL CANAL AND CERVIX BY INSERTING A SPECIALLY DESIGNED PENCIL OR PROBE INTO THE REPRODUCTIVE TRACT OF THE CALF. THE TEST IS BASED ON THE ANATOMICAL DIFFERENCES BETWEEN FERTILE FEMALES AND FREEMARTINS, WHICH CAN BE DETECTED THROUGH CAREFUL PHYSICAL EXAMINATION.

PRINCIPLE BEHIND THE PENCIL TEST

THE TEST OPERATES ON THE PRINCIPLE THAT FREEMARTIN HEIFERS HAVE AN UNDERDEVELOPED OR ABSENT VAGINAL CANAL AND CERVIX DUE TO HORMONAL INTERFERENCE DURING FETAL DEVELOPMENT. WHEN A PENCIL OR PROBE IS INSERTED, A FERTILE HEIFER WILL ALLOW THE DEVICE TO PASS EASILY INTO THE VAGINAL CANAL AND REACH THE CERVIX, WHEREAS IN FREEMARTINS, RESISTANCE OR AN ABNORMAL PASSAGE IS ENCOUNTERED. THIS TACTILE FEEDBACK HELPS IN MAKING A PRELIMINARY DIAGNOSIS OF THE ANIMAL'S REPRODUCTIVE STATUS.

EQUIPMENT USED

THE PRIMARY EQUIPMENT USED IN THE FREE MARTIN HEIFER PENCIL TEST IS A CLEAN, SMOOTH PENCIL OR A SPECIALIZED VAGINAL PROBE DESIGNED FOR LIVESTOCK EXAMINATION. THE PENCIL SHOULD BE STERILIZED TO PREVENT INFECTION AND MUST BE OF APPROPRIATE SIZE TO FIT COMFORTABLY INTO THE CALF'S REPRODUCTIVE TRACT WITHOUT CAUSING INJURY. SOME VETERINARIANS USE DISPOSABLE VAGINAL SPECULUMS OR PROBES FOR MORE PRECISE EXAMINATION, BUT THE PENCIL TEST REMAINS POPULAR FOR ITS SIMPLICITY AND ACCESSIBILITY.

PROCEDURE AND INTERPRETATION OF THE PENCIL TEST

PERFORMING THE FREE MARTIN HEIFER PENCIL TEST REQUIRES SKILL AND CARE TO ENSURE ACCURATE RESULTS AND ANIMAL WELFARE. THIS SECTION OUTLINES THE STEP-BY-STEP PROCEDURE AND EXPLAINS HOW TO INTERPRET THE FINDINGS TO DETERMINE IF A HEIFER IS A FREEMARTIN.

STEP-BY-STEP PROCEDURE

1. RESTRAIN THE CALF GENTLY TO MINIMIZE STRESS AND MOVEMENT.
2. CLEAN THE EXTERNAL GENITAL AREA THOROUGHLY TO MAINTAIN HYGIENE.
3. LUBRICATE THE PENCIL OR PROBE TO FACILITATE SMOOTH INSERTION.
4. INSERT THE PENCIL CAREFULLY INTO THE VAGINAL OPENING, ADVANCING SLOWLY.
5. OBSERVE THE RESISTANCE ENCOUNTERED AND NOTE THE LENGTH OF INSERTION POSSIBLE.
6. WITHDRAW THE PENCIL GENTLY AND ASSESS THE FINDINGS.

INTERPRETING TEST RESULTS

THE INTERPRETATION HINGES ON THE EASE OF INSERTION AND THE ANATOMICAL LANDMARKS FELT DURING THE TEST.

- **FERTILE HEIFER:** THE PENCIL PASSES SMOOTHLY THROUGH THE VAGINAL CANAL AND CONTACTS THE CERVIX, INDICATING NORMAL REPRODUCTIVE TRACT DEVELOPMENT.
- **FREEMARTIN HEIFER:** THE PENCIL ENCOUNTERS SIGNIFICANT RESISTANCE EARLY, OR THE VAGINAL CANAL IS SHORT OR ABSENT, SUGGESTING INCOMPLETE REPRODUCTIVE TRACT FORMATION CONSISTENT WITH FREEMARTINISM.

ALTHOUGH THE PENCIL TEST PROVIDES RAPID PRELIMINARY RESULTS, IT SHOULD BE COMPLEMENTED WITH OTHER DIAGNOSTIC METHODS IN AMBIGUOUS CASES.

BENEFITS AND LIMITATIONS OF THE PENCIL TEST

THE FREE MARTIN HEIFER PENCIL TEST OFFERS SEVERAL ADVANTAGES FOR CATTLE BREEDERS BUT ALSO POSES CERTAIN LIMITATIONS. UNDERSTANDING THESE FACTORS HELPS IN DECIDING WHEN AND HOW TO USE THIS DIAGNOSTIC TOOL EFFECTIVELY.

ADVANTAGES

- **COST-EFFECTIVE:** REQUIRES MINIMAL EQUIPMENT AND NO SPECIALIZED LABORATORY FACILITIES.
- **QUICK AND EASY:** CAN BE PERFORMED ON-SITE SHORTLY AFTER BIRTH.
- **NON-INVASIVE:** CAUSES MINIMAL DISCOMFORT WHEN CONDUCTED PROPERLY.
- **IMMEDIATE RESULTS:** ENABLES PROMPT DECISION-MAKING REGARDING ANIMAL MANAGEMENT.

LIMITATIONS

- **OPERATOR-DEPENDENT:** ACCURACY DEPENDS ON THE EXPERIENCE AND SKILL OF THE EXAMINER.
- **NOT DEFINITIVE:** CANNOT DETECT ALL FREEMARTINS, ESPECIALLY THOSE WITH PARTIAL REPRODUCTIVE TRACT DEVELOPMENT.
- **RISK OF INJURY:** IMPROPER TECHNIQUE MAY CAUSE TRAUMA OR INFECTION.
- **AMBIGUOUS RESULTS:** SOME ANIMALS MAY EXHIBIT INTERMEDIATE FINDINGS REQUIRING FURTHER TESTING.

ALTERNATIVE METHODS FOR FREEMARTIN DIAGNOSIS

GIVEN THE LIMITATIONS OF THE PENCIL TEST, SEVERAL ALTERNATIVE AND COMPLEMENTARY DIAGNOSTIC TECHNIQUES HAVE BEEN DEVELOPED TO ACCURATELY IDENTIFY FREEMARTINS. THESE METHODS VARY IN COMPLEXITY, COST, AND ACCURACY.

BLOOD HORMONE ANALYSIS

MEASURING LEVELS OF HORMONES SUCH AS TESTOSTERONE AND ANTI-M_{LL}ERIAN HORMONE IN THE BLOOD CAN PROVIDE BIOCHEMICAL EVIDENCE OF FREEMARTINISM. ELEVATED LEVELS OF THESE HORMONES IN A FEMALE CALF SUGGEST MASCULINIZATION OF THE REPRODUCTIVE TRACT.

CHROMOSOMAL AND GENETIC TESTING

GENETIC ANALYSIS, INCLUDING KARYOTYPING OR PCR-BASED TESTS, CAN DETECT THE PRESENCE OF MALE (XY) CELLS IN THE BLOOD OR TISSUES OF THE FEMALE TWIN. THE PRESENCE OF MIXED-SEX CELL POPULATIONS CONFIRMS FREEMARTIN STATUS WITH HIGH ACCURACY.

ULTRASOUND EXAMINATION

VETERINARIANS USE ULTRASOUND IMAGING TO VISUALIZE THE REPRODUCTIVE ORGANS OF THE HEIFER. FREEMARTINS TYPICALLY SHOW UNDERDEVELOPED OVARIES AND UTERINE STRUCTURES, WHICH CAN BE DETECTED WITH THIS NON-INVASIVE TECHNIQUE.

PRACTICAL APPLICATIONS IN CATTLE BREEDING MANAGEMENT

IMPLEMENTING THE FREE MARTIN HEIFER PENCIL TEST AS PART OF ROUTINE HERD EVALUATION ENABLES BETTER MANAGEMENT DECISIONS THAT ENHANCE BREEDING EFFICIENCY AND ECONOMIC RETURNS. THIS SECTION OUTLINES HOW THE TEST INTEGRATES INTO CATTLE BREEDING PRACTICES.

EARLY IDENTIFICATION AND CULLING

IDENTIFYING FREEMARTINS SHORTLY AFTER BIRTH ALLOWS PRODUCERS TO CULL STERILE HEIFERS EARLY, AVOIDING UNNECESSARY FEEDING AND BREEDING ATTEMPTS. THIS PRACTICE REDUCES COSTS AND IMPROVES OVERALL HERD FERTILITY RATES.

OPTIMIZING BREEDING PROGRAMS

BY EXCLUDING FREEMARTINS FROM BREEDING, CATTLE OPERATIONS CAN FOCUS RESOURCES ON GENETICALLY VALUABLE AND FERTILE FEMALES. THIS HELPS MAINTAIN A PRODUCTIVE AND SUSTAINABLE HERD OVER TIME.

RECORD KEEPING AND GENETIC SELECTION

RECORDING THE RESULTS OF THE PENCIL TEST CONTRIBUTES TO ACCURATE HERD RECORDS AND INFORMS SELECTIVE BREEDING STRATEGIES. KNOWING THE REPRODUCTIVE STATUS OF EACH ANIMAL SUPPORTS DECISIONS REGARDING MATING PAIRS AND GENETIC IMPROVEMENT.

TRAINING AND PROTOCOL DEVELOPMENT

INCORPORATING THE PENCIL TEST INTO VETERINARY AND FARM STAFF TRAINING ENSURES CONSISTENT AND RELIABLE APPLICATION. DEVELOPING STANDARD OPERATING PROCEDURES ENHANCES TEST ACCURACY AND ANIMAL WELFARE.

FREQUENTLY ASKED QUESTIONS

WHAT IS A FREE MARTIN HEIFER PENCIL TEST?

A FREE MARTIN HEIFER PENCIL TEST IS A SIMPLE, INFORMAL METHOD USED BY FARMERS TO IDENTIFY IF A HEIFER (YOUNG FEMALE COW) IS A FREE MARTIN, MEANING SHE IS A STERILE FEMALE TWIN BORN WITH A MALE. THE TEST INVOLVES OBSERVING PHYSICAL CHARACTERISTICS AND SOMETIMES USING A PENCIL TO CHECK FOR REPRODUCTIVE TRACT ABNORMALITIES.

WHY IS IT IMPORTANT TO PERFORM A PENCIL TEST ON A FREE MARTIN HEIFER?

PERFORMING A PENCIL TEST HELPS FARMERS QUICKLY IDENTIFY FREE MARTIN HEIFERS, WHICH ARE USUALLY STERILE AND HAVE LITTLE REPRODUCTIVE VALUE. THIS ALLOWS FOR BETTER HERD MANAGEMENT AND DECISION-MAKING REGARDING BREEDING AND CULLING.

HOW ACCURATE IS THE FREE MARTIN HEIFER PENCIL TEST COMPARED TO LABORATORY TESTS?

THE PENCIL TEST IS A ROUGH, PRELIMINARY CHECK AND IS LESS ACCURATE THAN LABORATORY METHODS SUCH AS BLOOD TESTS OR DNA ANALYSIS. WHILE IT CAN INDICATE POTENTIAL FREE MARTIN STATUS, CONFIRMATORY TESTS ARE RECOMMENDED FOR DEFINITIVE DIAGNOSIS.

CAN A FREE MARTIN HEIFER BECOME PREGNANT IF IDENTIFIED BY THE PENCIL TEST?

GENERALLY, FREE MARTIN HEIFERS ARE STERILE AND CANNOT CONCEIVE. HOWEVER, IN RARE CASES WHERE THE TEST IS INCONCLUSIVE OR INCORRECT, SOME FEMALES MAY HAVE PARTIAL FERTILITY, SO FURTHER TESTING IS ADVISABLE.

WHAT PHYSICAL SIGNS DOES THE PENCIL TEST LOOK FOR IN A FREE MARTIN HEIFER?

THE PENCIL TEST TYPICALLY LOOKS FOR ABNORMALITIES IN THE VULVA, VAGINAL LENGTH, AND PRESENCE OF A VAGINAL THREAD OR MEMBRANE, WHICH ARE INDICATIVE OF FREE MARTINISM DUE TO SHARED BLOOD CIRCULATION WITH A MALE TWIN.

AT WHAT AGE CAN THE FREE MARTIN HEIFER PENCIL TEST BE PERFORMED?

THE PENCIL TEST CAN USUALLY BE PERFORMED ON HEIFERS A FEW WEEKS TO A FEW MONTHS OLD, ONCE THE REPRODUCTIVE TRACT IS SUFFICIENTLY DEVELOPED TO OBSERVE DIFFERENCES, OFTEN AROUND 1 TO 3 MONTHS OF AGE.

IS THE FREE MARTIN HEIFER PENCIL TEST USED WORLDWIDE?

THE PENCIL TEST IS MOSTLY USED IN REGIONS WHERE QUICK AND LOW-COST IDENTIFICATION OF FREE MARTIN HEIFERS IS NEEDED. MORE DEVELOPED FARMING OPERATIONS MAY PREFER LAB-BASED TESTS, BUT THE PENCIL TEST REMAINS POPULAR IN MANY PARTS OF THE WORLD.

ARE THERE ANY RISKS OR HARMS INVOLVED IN PERFORMING THE PENCIL TEST ON HEIFERS?

WHEN PERFORMED GENTLY AND CORRECTLY, THE PENCIL TEST POSES MINIMAL RISK TO THE ANIMAL. HOWEVER, IMPROPER TECHNIQUE OR EXCESSIVE FORCE CAN CAUSE DISCOMFORT OR INJURY, SO IT SHOULD BE DONE CAREFULLY OR BY EXPERIENCED PERSONNEL.

ADDITIONAL RESOURCES

1. *UNDERSTANDING THE FREE MARTIN HEIFER PHENOMENON: BIOLOGY AND IMPLICATIONS*

THIS BOOK EXPLORES THE BIOLOGICAL BASIS OF THE FREE MARTIN CONDITION IN CATTLE, FOCUSING ON THE GENETIC AND HORMONAL FACTORS THAT INFLUENCE SEXUAL DEVELOPMENT. IT PROVIDES DETAILED EXPLANATIONS OF HOW AND WHY FREE MARTIN HEIFERS OCCUR, HIGHLIGHTING THE IMPORTANCE OF EARLY DIAGNOSIS. THE TEXT IS ESSENTIAL FOR VETERINARY STUDENTS AND LIVESTOCK BREEDERS SEEKING TO UNDERSTAND THIS UNIQUE PHENOMENON.

2. *PENCIL TEST TECHNIQUES IN VETERINARY DIAGNOSTICS*

A COMPREHENSIVE GUIDE TO THE PENCIL TEST AND OTHER DIAGNOSTIC METHODS USED IN VETERINARY MEDICINE, THIS BOOK EMPHASIZES PRACTICAL APPLICATIONS IN IDENTIFYING FREE MARTIN HEIFERS. IT COVERS PROCEDURAL STEPS, INTERPRETATION OF RESULTS, AND CASE STUDIES TO HELP VETERINARIANS AND FARMERS IMPLEMENT ACCURATE TESTING. THE BOOK ALSO DISCUSSES ADVANCEMENTS IN DIAGNOSTIC TECHNOLOGY.

3. *FREE MARTIN HEIFER MANAGEMENT AND BREEDING STRATEGIES*

FOCUSING ON LIVESTOCK MANAGEMENT, THIS BOOK DISCUSSES HOW TO HANDLE FREE MARTIN HEIFERS WITHIN A HERD. IT OFFERS BREEDING STRATEGIES TO MINIMIZE THE OCCURRENCE OF FREE MARTIN CASES AND IMPROVE HERD PRODUCTIVITY. THE BOOK ALSO ADDRESSES ETHICAL CONSIDERATIONS AND ECONOMIC IMPACTS FOR CATTLE PRODUCERS.

4. *GENETICS AND ENDOCRINOLOGY OF FREE MARTINISM*

DELVING DEEP INTO THE GENETIC AND HORMONAL UNDERPINNINGS OF FREE MARTIN HEIFERS, THIS ACADEMIC TEXT IS IDEAL FOR RESEARCHERS AND ADVANCED STUDENTS. IT EXPLAINS THE CHROMOSOMAL ANOMALIES AND ENDOCRINE DISRUPTIONS THAT LEAD TO THE FREE MARTIN CONDITION. DETAILED DIAGRAMS AND RESEARCH DATA SUPPORT THE SCIENTIFIC DISCUSSION.

5. *DIAGNOSTIC TOOLS FOR IDENTIFYING FREE MARTIN HEIFERS: FROM PENCIL TEST TO MOLECULAR METHODS*

THIS BOOK PROVIDES AN OVERVIEW OF BOTH TRADITIONAL AND MODERN DIAGNOSTIC TOOLS USED TO IDENTIFY FREE MARTIN HEIFERS. IT COMPARES THE PENCIL TEST WITH MOLECULAR TECHNIQUES SUCH AS PCR AND KARYOTYPING, WEIGHING THEIR ADVANTAGES AND LIMITATIONS. THE BOOK IS VALUABLE FOR VETERINARIANS AND RESEARCHERS INTERESTED IN ACCURATE DIAGNOSIS.

6. *FREE MARTIN HEIFERS: CASE STUDIES AND FIELD REPORTS*

AN ANTHOLOGY OF REAL-LIFE CASES INVOLVING FREE MARTIN HEIFERS, THIS BOOK GIVES READERS INSIGHTS INTO PRACTICAL CHALLENGES AND SOLUTIONS IN THE FIELD. IT INCLUDES REPORTS FROM CATTLE FARMS, VETERINARY CLINICS, AND RESEARCH INSTITUTIONS. THE NARRATIVES HELP BRIDGE THE GAP BETWEEN THEORY AND PRACTICE.

7. *ADVANCES IN REPRODUCTIVE BIOLOGY: THE FREE MARTIN HEIFER PUZZLE*

HIGHLIGHTING RECENT SCIENTIFIC ADVANCES, THIS BOOK EXAMINES NEW FINDINGS IN REPRODUCTIVE BIOLOGY RELATED TO FREE MARTIN HEIFERS. IT COVERS CUTTING-EDGE RESEARCH ON FETAL DEVELOPMENT, SEXUAL DIFFERENTIATION, AND DIAGNOSTIC INNOVATIONS. THE BOOK AIMS TO INSPIRE FURTHER STUDY AND INNOVATION IN THE FIELD.

8. *VETERINARY GUIDE TO SEX DETERMINATION IN CATTLE*

THIS PRACTICAL GUIDE COVERS VARIOUS METHODS OF SEX DETERMINATION IN CATTLE, WITH A DEDICATED SECTION ON THE PENCIL TEST FOR FREE MARTIN DIAGNOSIS. IT PROVIDES STEP-BY-STEP INSTRUCTIONS, TROUBLESHOOTING TIPS, AND ILLUSTRATIONS TO AID VETERINARIANS AND FARMERS. THE BOOK PROMOTES ACCURATE SEXING TECHNIQUES TO IMPROVE HERD MANAGEMENT.

9. *HORMONAL AND MORPHOLOGICAL ASSESSMENT OF FREE MARTIN HEIFERS*

FOCUSING ON THE PHYSIOLOGICAL ASPECTS, THIS BOOK DETAILS THE HORMONAL PROFILES AND MORPHOLOGICAL CHARACTERISTICS OF FREE MARTIN HEIFERS. IT OFFERS INSIGHTS INTO HOW THESE FACTORS AFFECT FERTILITY AND OVERALL HEALTH. THE CONTENT IS USEFUL FOR VETERINARY ENDOCRINOLOGISTS AND ANIMAL SCIENTISTS WORKING ON CATTLE REPRODUCTION.

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