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Biotechnology — Biobanking — Requirements for the biobanking of plant biological material for research and development

Biotechnologie — Biobanking — Exigences relatives au biobanking de matériels biologiques végétaux pour la recherche et le développement

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 276, *Biotechnology*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Biobanking of plant biological materials is fundamental for botanical and agro-ecosystem research, sustainable crop development and production, ensuring genetic diversity and conservation. Biobank biological material collection and accession management are strategic to optimizing plant genetic resources. A plant biobank obtains its accessions in different ways, e.g. from donors (principally researchers or breeders), by collecting the biological material from the field and by exchange with other plant biobanks. Biological collections encompass numerous biological material types, including frozen plant tissues, fluid preserved plant tissues or associated extracts or some or all of them. These collections often require specialized experts to curate and assemble the collection. Appropriate biological material processing and storage conditions are also needed to maintain high-quality collections and maximize the potential of positive outcomes. This document provides guidance on how to collect, process, store, track and distribute plant biological materials.

Standards are needed for the collection, preparation, preservation, transportation and storage of plant biological materials for academic institutions, non-profit organizations and commercial agronomic businesses. This document provides the specific requirements, guidelines and effective practices for biobanking plant biological materials based on the current and available technological and scientific knowledge.

Biotechnology — Biobanking — Requirements for the biobanking of plant biological material for research and development

1 Scope

This document specifies requirements for the collection, preparation, preservation, transportation, storage, distribution and disposal of plant biological materials and associated data.

This document is applicable only to biological material that can be used for further processing of biomolecules, e.g. nucleic acids, proteins and metabolites.

This document is applicable to all organizations performing plant biobanking for research and development.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 20387:2018, *Biotechnology — Biobanking — General requirements for biobanking*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
associated data
any information affiliated with *biological material* (3.4) including but not limited to research, phenotypic, clinical, epidemiologic, phytosanitary certificate and procedural data

Note 1 to entry: Associated data can include metadata.

[SOURCE: ISO 20387:2018, 3.3, modified — "phytosanitary certificate" and Note 1 to entry have been added.]

3.2
biobank
legal entity or part of a legal entity that performs *biobanking* (3.3)

[SOURCE: ISO 20387:2018, 3.5]

3.3
biobanking
process of acquisitioning and storing, together with some or all of the activities related to collection, preparation, *preservation* (3.9), testing, analysing and distributing defined *biological material* (3.4) as well as related information and data

[SOURCE: ISO 20387:2018, 3.6]

3.4
biological material
<plant material biobanking> plant as a whole, or any substance derived or part obtained from the plant entity

3.5
dried spots card
card containing chemicals that lyse cells, denature proteins and protect nucleic acids from nucleases as well as from oxidative and ultraviolet damage; can be used to process plant *biological material* (3.4) homogenates

3.6
life cycle
consecutive and interlinked processes applied to *biological material* (3.4) and *associated data* (3.1) from collection, if applicable, acquisition or reception to distribution, disposal or destruction

Note 1 to entry: This term refers to the *biobanking* (3.3) life cycle only.

[SOURCE: ISO 20387:2018, 3.29]

3.7
plant genetic resource
genetic material of plant origin, containing functional units of heredity (e.g. DNA or RNA), or elements thereof (e.g. mRNA, mtDNA)

3.8
plant biobank
plant genetic resource bank
plant gene bank
plant BRC
legal entity or part of a legal entity that performs the process of acquisitioning and storing, as well as some or all of the following activities: collection, preparation, *preservation* (3.9), testing, analysing and distributing defined *plant genetic resource* (3.7) as well as related information and data

Note 1 to entry: "Plant BRC" stands for "Plant Biological Resource Center".

3.9
preservation
act of preventing or retarding biological or physical deterioration of *biological material* (3.4)

[SOURCE: ISO 20387:2018, 3.34, modified — "act of preventing or retarding" has replaced "act to prevent or retard".]

3.10
processing
performing any activity on *biological material* (3.4) and *associated data* (3.1) during all stages of the *life cycle* (3.6)

[SOURCE: ISO 20387:2018, 3.36]

3.11
rejuvenation
growth of a vegetative propagule

3.12
vegetative structures
whole or portion of a plant not including the seeds

Note 1 to entry: In the scope of this document, vegetative structures can include propagules.

4 General requirements

The biobank shall follow ISO 20387:2018, Clauses 4 to 7.

The biobank shall establish, implement and maintain a quality management system in accordance with ISO 20387:2018, Clause 8.

The biobank shall identify each biological material and associated data relevant to the application of this document.

The biobank shall have procedures addressing biobanking for each type of biological material (e.g. whole plant, seeds, tuber, bulbs, scion wood, leaf, root, DNA, RNA) and associated data. This includes processes such as collection, acquisition, reception, characterization/evaluation, storage, preparation, preservation, rejuvenation and distribution.

The biobank shall ensure the legitimate acquisition of biological material and its associated data, and the retention of any relevant documentation. If legitimate acquisition cannot be demonstrated, the biological material shall be discarded, according to documented procedures, and this shall be documented.

NOTE 1 Such documentation can relate to relevant documents such as international treaties and agreements, and a phytosanitary certificate or passport.

NOTE 2 Legitimate acquisition can refer to relevant regulation, permits or authorization.

The biobank shall ensure that biorisk management procedures (e.g. ISO 35001, WHO guidance[3]) for potential plant pests and pathogens are established, documented, implemented and maintained, as appropriate.

The biobank shall take measures to prevent cross contamination.

The biobank or the legal entity of which it is a part shall ensure that human health and safety requirements are established, documented, implemented and maintained. The level of safety training required shall be determined using a comprehensive risk assessment of the biological and chemical materials, processes and equipment that is handled (see ISO 20387:2018, 6.2.1.5).

5 Biological material collection

5.1 General

Where possible, the intended purpose or final use of the biological material and associated data shall be determined, either by the biobank alone, in response to end-user criteria or by the biobank in conjunction with the end user. If determined, the intended or potential purpose shall be documented.

5.2 Collection procedure

5.2.1 The biobank shall develop and implement documented biological material collection procedures appropriate for each type of biological material according to its biological nature and intended purpose, where known. The biobank shall define biological material acceptance criteria.

5.2.2 The collection procedure shall address requirements for authentication, minimum quantity, viability, stability and maintenance to satisfy the fitness for purpose, where known. The collection procedure shall also address the following aspects, including but not limited to:

a) biological material type;

b) fitness for purpose, where known;

c) total number and amount comprising each biological material per collection;

d) containers that are fit for purpose (e.g. closure integrity, composition);

e) equipment;

f) collection method;

g) quality criteria for each biological material (e.g. the quantity and quality of targeted analytes such as DNA, RNA or protein);

h) collection location(s) (e.g. by GPS), schedule, personnel and assignment;

i) stage of maturity of the biological material.

5.2.3 When developing collection procedures, the following information shall be evaluated for inclusion:

a) taxonomic information, vernacular names, morphological characters and habitat;

b) geographical distribution and known populations;

c) population size and identified number of propagules to be collected;

d) recognized identification system of propagules;

e) statistical demographics for collection;

f) physiological traits that are relevant for plant biological material sampling;

g) information on putative plant disease or associated pests;

h) historical collection information, the appropriate season and timing for collection, and environmental information such as climate and accessibility;

i) permits required for collection, transportation, export and import.

The evaluation result shall be documented.

5.2.4 The biobank shall identify risks associated with the collection procedure for each biological material and take appropriate feasible measure(s) to mitigate the risks according to the likelihood of occurrence and the possible impacts. It is up to the biobank or the legal entity of which it is a part, or both, to determine what measures are appropriate and feasible.

5.2.5 The biobank shall define and document information related to the biological material (see Annex B and ISO 20387:2018, 7.2.1.1, 7.2.1.2, A.2 and B.2).

5.3 Preparation of collection containers, tools, supplies, reagents and consumables

The tools for collection, such as instruments, consumables and personal protective equipment, should be prepared and checked prior to collection. Preparing a checklist before collection can help to ensure an uninterrupted and efficient procedure.

The collection procedure shall include the preparation of collection containers, tools and other supplies (e.g. ink, labels or tags) required for each biological material collection. When appropriate, this shall include, but is not limited to, the following:

a) collection containers and seals;

b) contamination prevention through appropriate care, cleaning or sterilization or both of collection tools such as cutting devices, instruments, containers and reagents;

c) collection instruments;

d) collection consumables;

e) personal protective equipment;

f) information recording tools;

g) reminder systems, e.g. checklists.

NOTE When needed, containers, instruments and consumables can be sterilized prior to collection.

Specifications for collection container, tool, supply, reagent and consumable requirements and recommendations by type of biological material are listed in Table 1.

Table 1 — Collection container, tool, supply, reagent and consumable specifications by type of biological material

Biological material type	Specifications
Vegetative structures (whole or part)	Containers shall be clean and able to maintain the desired moisture content or temperature, e.g. aluminium foil can be used. If necessary, biological material, especially those containing plastids, should be protected from light (e.g. aluminium foil wrapping, dark containers). Air should be excluded as much as possible. Debris, where present, should be removed, e.g. through use of a soft brush or clean water or both.
Seeds	Containers to maintain the desired moisture content range or which keep the biological material dry/cool shall be prepared before collection, according to the biological material properties and intended purpose. Seeds should be collected into containers minimizing light and air. As much as possible, seeds should be collected with minimized debris.
Biological material for biomolecular research	A container designed to minimize sample degradation, e.g. DNase free or RNase free or pyrogen free to preserve genetic integrity, should be used. Clean cryotubes with secure top lids or appropriate sealable plastic bags produced by clean manufacturing technology can be selected for transportation and storage at or below −18 °C. Dehydration shall be avoided in the container. Debris, where present, should be removed, e.g. through use of a soft brush or clean water or both. Use a collection receptacle appropriate for the biological material collection criteria, e.g. containers capable of maintaining desired moisture content or temperature range, aluminium foil to minimize exposure to light/air. Care should be taken during collection and processing to prevent the activity of RNases, both endogenous and those introduced by environmental contamination.

5.4 Biological material traceability

The biobank shall follow ISO 20387:2018, 7.5, 7.7.2, 7.7.4 and 7.10.

The label or tag shall not inhibit fitness of purpose of the biological material and associated data for the intended purpose, where known.

A system (e.g. double tag, mapping of storage) shall be applied to prevent the loss of biological material identity.

The label or tag can also be tied to the biological material or pasted on the container. Containers shall be appropriately labelled or tagged to prevent the tag from fading or falling off so that identification is maintained throughout the life cycle of the biological material.

5.5 Collection

Information defined as relevant to the collection procedure shall be documented in a traceable manner.

Multiple individuals from the same population should be collected to meet the minimum number and amount requirements detailed in the collection procedure.

Biological material should be collected without visible parasitic or microbial contaminants unless these are the target material. If necessary, a treatment prior to conservation or use or both shall be applied.

Individual biological material should be collected in separate containers.

Collection specifications by type of biological material are listed in Table 2.

Table 2 — Collection specifications by type of biological material

Biological material type		Specifications
Vegetative structures (whole or part)	Whole plant	If collecting the entire plant, live collection should be performed. The plant material should be kept under conditions similar to the original habitat. The collected plant should grow normally without injury. Where appropriate, remove the majority of leaves to reduce transpiration, retain at least one node, wrap with moist material (e.g. wet newspaper) and protect against contamination; non-seed propagules are also suitable.
	Tuber, bulbs or root	The vegetative propagules (i.e. tuber, bulbs and roots) should remain healthy and without injury. The remaining propagators should not be so small as to hinder the natural regeneration of the plant population. The tuber, bulb or root should be carefully dug out from the ground during collection, paying attention to its branching. When transferring the tuber, bulb or root from the place of harvest into a prepared container, the harvested biological material should be protected against contamination.
	Scionwood	The majority of leaves should be removed to reduce transpiration. The scionwood should be kept in ambient conditions.
	Pollen	For plants with heavy dry pollen, the flowers can be beaten over a 500 µm sieve. When no free pollen is available, anthers can be collected. NOTE Anthers release the pollen from the inside after they are dried. For in wind fertilized species, male flowers should be enclosed within paper bags to collect the pollen in a sufficient quantity.
	Leaves	Collected leaves can be put into a container to keep the necessary water regime.

Table 2 *(continued)*

Biological material type		Specifications
Biological material for biomolecular research	Care should be taken during collection and processing to prevent the activity of RNases, both endogenous and those introduced by environmental contamination. For RNA or protein research, collection should minimize the conditions that degrade or alter the RNA or proteome.	
	Leaves	Young (but not too young), fresh, undamaged leaves should be used. Diseased, damaged, dead plant material and leaves stressed by excessive heat, cold or moisture should generally be avoided. For larger plants, the most recent mature leaf (MRML), which is the first fully expanded leaf below the growing point, should be used. If an envelope with silica gel is used, the leaf can be cut into pieces before putting it into the envelope. The envelope should not be overfilled. For better drying, adding large clumps of leaves to the envelope should be avoided. The air should be pushed out of the envelope; afterwards, the envelope should be sealed tight.
	Tuber, bulbs or root	Removal of any adhering soil can be done by brushing and, if necessary, gently rinsing with cold running water. Tops can be trimmed off. Details of any trimming should be documented. The trimmed tops should be bagged separately, if needed.
Seeds		The biobank shall define the moisture level for seed preservation. The defined storage humidity depends on the kind of seeds. It is recommended to take at minimum between 30 samples and 60 samples by accession according to the biological status and multiplication method. For endangered populations, no more than 20 % of the available seeds may be collected. The frequency of empty or damaged seeds should be estimated. The maturity of the seeds should be evaluated. Seeds should be high viability, free from diseases and pests, and able to maintain adequate levels of germination. The biological material should comprise at least 500 viable seeds for outbreeders and heterogeneous accessions with high diversity and a minimum of 300 seeds for genetically uniform accessions.
Other biological materials	Bryophytes	The entirety of living parts should be collected, preferentially in the sporophytes phase, including fruiting bodies, when available.
	Fern	If frond is needed, young fully expanded mature fern should be used. Spores can be collected from the fertile frond bearing sori or sporangia. Ripe and mature sporangia should be collected. Any soil or dust on the frond surfaces should be gently brushed or washed off. The fertile frond should be placed with the sporangia side down into a clean leak-proof container (e.g. paper). The fertile frond should be covered to prevent air movement. Spores are usually shed in about one week. Cellophane or plastic bags should not be used as the spores will stick to their surfaces. Spores should be separated from chaff. If time is limited, ripe sporangia can be scraped off the frond.

6 Transport of biological material and associated data

The general requirements for transport in ISO 20387:2018, 7.4 shall be followed.

The biobank shall define the risks associated with the transport and shipping of biological material. It shall take appropriate feasible measures to mitigate the risks according to the likelihood of occurrence and the possible impacts. It is up to the biobank or legal entity of which it is a part, or both, to determine

what measures are appropriate and feasible. Areas to consider are mode of transportation/shipment specifications, temperature during transport, and temperature or temperature range at reception.

The biobank should refer to ISO 16106:2018, Annex A, if packaging dangerous biological material.

The biobank shall request and verify certification documents before transportation, including related information (e.g. "Sample Transfer Form", "Material Transfer Agreement", "Sample Information Sheet"), transport-related documents (e.g. "Delivery Waybill"), and required permits or certifications by origin or destination country, and phytosanitary passport.

Prior to transport of rare biological material, the biobank should perform risk assessment, appropriately mitigate and use suitable solutions as deemed necessary. For example, the biobank can simulate the conditions of transport prior to biological material transport to identify potential risks.

The biobank should define and document specified conditions (e.g. temperature, humidity) during transportation.

For fluid-preserved biological material, unbreakable, leak-proof and ethanol-resistant plastic vials should be used to avoid evaporation or spillage. Sealing the vials inside thick, ethanol-resistant plastic sleeves is advised as a further precaution.

Specifications by type of biological material are listed in Table 3.

Table 3 — Transportation specifications by type of biological material

Biological material type		Specifications
Vegetative structures (whole or part)	Whole plant	Vegetative structures should be transported in moist conditions at ambient temperature. Freezing, dehydration and overheating should be prevented during transportation.
	Tuber or bulbs	
	Scionwood	
	Root	
Seeds (orthodox)		Seeds can be transported at ambient temperature.
Biological material (leaf, stem, root, etc.) for extraction of derivatives such as DNA, RNA or protein		Fluid-preserved biological material should be maintained at or below 4 °C during transportation. Frozen biological material shall be maintained at or below −20 °C during transportation. When metabolite-related research is the intended purpose, biological material should be transported on dry ice or in a container with liquid nitrogen.

7 Preparation and preservation of biological material

7.1 General

The biobank shall develop, implement and document biological material preparation and preservation procedures appropriate for each type of biological material.

The preparation and preservation procedures contribute to the fitness of the intended use of the biological material or associated data or both, where known, and efforts to address the mitigation and prevention of identified risks shall be included in these procedures.

7.2 Cutting, cleaning and bagging

For plant biological material with a thick, leathery and highly cutinized and waxy epidermis, the biological material can be subdivided into smaller pieces to increase specific surface area in both longitudinal and transverse sections.

For biological material needing to be cleaned, soil and other impurities from the biological material shall be removed carefully to prevent damage and ensure the completeness of the biological material. Sterile distilled water should be used to avoid ionic or microbial effects. Washing solutions and times of washes may vary depending on the specific research purpose.

The biobank shall define and document the bagging method used, e.g. the use of hermetically sealed containers or trilaminate pouches to ensure control of water content of the biological material.

7.3 Desiccation

The biobank shall define the desiccation method (e.g. desiccating agent, drying room, level of moisture, temperature), if reducing the water content of the biological material is necessary.

For desiccation, 10 times the mass of desiccant (e.g. silica gel) should be used. For seeds, a mass ratio of 1:1 desiccant to seeds can be used. Immediately upon collection, the material should be placed into a container with the desiccant. The container shall be sealed to limit the effects of atmospheric humidity.

NOTE After 48 h of desiccation, the water content is reduced to approximately 40 % depending on species and biological material type.

The desiccating agent should remain dry during the whole process and changed when the colour of the moisture indicator dye changes.

Biological material with high moisture content can be divided to speed up the drying process. Biological material should not be dried at high temperature.

After the desiccation process, the biological material shall be preserved in an airtight container to avoid the natural increase of moisture content.

The defined humidity for the desiccated biological material should be maintained. For example, a hygrometer can be placed in the container to monitor the humidity. Actions shall be taken when a deviation is found.

7.4 Snap freezing and cryopreservation

Snap freezing in liquid nitrogen can be used to preserve biological material, when fit for the intended purpose.

NOTE Snap freezing is not applicable for mitochondrial DNA because it is known to decrease yields of intact mitochondrial DNA.

Fleshy portions of the biological material should be removed and dried first. The embryo, sporophytes and gametophytes should be separated before downstream processing.

The biological material should be cut into the appropriate size using a sharp blade or surgical scissors, as needed, to reduce the number of freeze–thaw cycles. Each aliquot should be representative of the whole biological material.

The biobank shall define the method used and ensure the viability and compliance of the material stored after it has been removed from storage.

7.5 Fast or rapid drying

7.5.1 General

When DNA analysis is the intended purpose, rapid drying with desiccating agents or with a dried spots card can be used for processing the biological material.

For plant leaves that are non-succulent, non-woody and with a non-waxy epidermis, drying should be performed with desiccating agents. For succulent biological material, drying with a dried spots card can be more appropriate.

Biological material should be completely dried within 48 h, and should be dried in a cool, ambient temperature environment.

The drying process should be performed out of the sun as the ultraviolet light and high temperature can cause DNA degradation.

7.5.2 Drying with dried spots card

Leaves should be pressed and dried onto the dried spots card or similarly treated cellulose matrix and placed into a waterproof bag with a humidity indicator. This biological material can be transported and stored at ambient temperature.

The amount of DNA that can be stored on a dried spots card is limited, but can be sufficient for downstream applications such as the polymerase chain reaction (PCR), restriction fragment length polymorphism (RFLP) analysis and nucleotide sequencing.

7.5.3 Air-dried or oven-dried

For air-drying or oven-drying of biological material, the appropriate temperature range and moisture level should be defined and documented.

7.6 Grinding

For grinding biological material, grinders or a mortar and pestle should be used. Instruments shall be cleaned before each use.

Biological material should be prepared in a suitable size to comply with the instruments.

A protective agent should be used when grinding, e.g. liquid nitrogen.

7.7 Biological material preservation in protective solution

When biological material for biomolecular analysis is collected from locations where snap freezing and fast drying are not accessible, a sterile container or vial containing enough preservation media, such as cetyltrimethylammonium bromide, ethanol or other commercial fluid preservatives, can be used to temporarily maintain biological material stability at ambient temperature.

Biological material, which will be used for RNA extraction, should be preserved quickly (within a few minutes) after collection.

The combined volume of the sample and preservative should not exceed two-thirds of the container capacity to accommodate any volume expansion during freezing without adversely affecting the container and/or the biological material.

Biological material should be cut into pieces less than 5 mm in thickness and submerged with a scalpel, if they float on the solution.

When appropriate, for long-term preservation at −20 °C, the biobank can incubate the biological material for up to 24 h in the preservation media at 2 °C to 8 °C prior to transferring it to the −20 °C freezer.

When appropriate, for long-term preservation at −80 °C, the biobank can incubate the biological material overnight in the preservation media at 2 °C to 8 °C. The biological material should be removed from the media prior to −80 °C storage.

8 Storage of biological material

8.1 General

The biobank shall develop and implement documented biological material storage procedures appropriate for each type of biological material.

The storage procedure contributes to the fitness of the intended use of the biological material or associated data or both, where known. Efforts to address the mitigation/prevention of identified risks shall be included in the procedures.

Collected biological material should be stored at the identified requisite temperature range.

The biobank shall define and consider the specific requirements for each type of biological material. The storage conditions can be chosen appropriately to maintain the viability and metabolic conditions, and reduce genetic drift.

Stored biological material shall be inventoried and identified. Their location shall be documented or mapped or both.

The biobank shall evaluate, as part of the storage procedure, the steps required to mitigate the risk of biological material loss, e.g. a maintenance plan, dual location storage of the same biological material.

Examples of storage conditions are listed in Table 4.

Table 4 — Examples of storage conditions by type of biological material

Biological material type		Storage technique or condition
Vegetative structures (whole or part)	Whole plant	Field, in situ, greenhouse, in vitro culture
	Meristems	Cryopreservation
	Tuber or bulbs	Defined temperature, or cold storage (2 °C to 8 °C)
	Scionwood or root	Cold storage (2 °C to 8 °C)
Seeds (orthodox)		Defined temperature (for short-term storage) Ultra-dry, freezer, cryopreservation (for long-term storage)
Plant part for biomolecular research		Dried or frozen in silica-gel or both, freezer, cryopreservation

8.2 Storage temperature

Typical biological material storage temperatures and storage durations can be found in Annex A.

The biobank shall organize storage processes to limit the duration and the number of freeze–thaw cycles (e.g. process for “active” bank or “reserve” bank, pre-bagging for distribution).

8.3 Biological material multiplication

The biobank shall determine and document the procedures for multiplication of biological material, if required. When developing a regeneration procedure, the biobank should consider the following:

a) source biological material;

b) acceptance criteria;

c) process validation;

d) output verification;

e) documentation of new information.

Original biological material shall be used to propagate new growth, unless compromised. Such compromised biological material shall be documented and instead the next generation shall be used for propagation, where available.

After multiplication, a verification of conformity with the original biological material and quality parameters determined in the multiplication process shall be carried out.

The biobank shall define the collection part and minimum quantity required for accession renewal without genetic drift. This biological material shall be retained in storage.

Recommendations for different types of biological materials are listed in Table 5.

Table 5 — Recommendations for different types of biological material

Biological material type	Recommendation
Whole plant	Living plants should be protected and propagated systematically according to human, material, financial, spatial and temporal resources.
Seeds	The minimum quantity allowing accession renewal is determined by the number of plants needed to avoid genetic drift, based on the biological status (i.e. population or line). In the first year after a possible dormancy period, the first viability test should be done after desiccation. The initial germination value should exceed 85 % for cultivated species although a lower value is acceptable for wild and some cultivated grassy species. Once regeneration is conducted, the original and the subsequent most original biological material are archived in long-term storage for reference.
Tuber or bulbs	Under normal temperature, the tuber is in dormancy for about one half of a year. After breaking dormancy, tubers without diseases and insect pests and with tidy body surface should be selected to reproduce, constituting formation of the newer buds from the mother tuber. During the formation of the new tuber, the mother tuber gradually becomes dry and withered.
Scionwood	It is recommended to choose biennial branches of woody plants or annual branches of herbs as cuttings. The selected branches are cut into 10 cm to 20 cm segments, and each segment should have two to three buds; transplant after survival is demonstrated.
Root	The root should be cut when replacing pots and for repairing roots, the plant cluster should not be larger than 20 cm and have as many roots as possible, all flower buds should be removed, which can promote the root growth.
Leaves	Healthy leaves should be placed in a dry and cool place, and then transplanted after rooting.

8.4 Monitoring of biological material

The biobank should define, document and implement a plan for planned interval monitoring of essential activities within the biobank, such as:

a) monitoring of defined critical environmental conditions, e.g. temperature, light, humidity;

b) plant health inspection;

c) biological material quality determination.

The plan should detail the responsibilities and responses, particularly for nonconformities.

A monitoring system should be installed to monitor and record real-time changes of environment and to raise an alarm at abnormal conditions.

Scheduled monitoring of biological material should be arranged for different biological material types; the necessary specifications are listed in Table 6.

Table 6 — Specifications for the monitoring of different biological material types

Biological material type	Specifications
Vegetative structures (whole or part)	The biobank shall ensure the monitoring of plant health according to different plant types, as well as temperature, humidity, light, pests and diseases.
Seeds	The biobank shall define and implement a plan to check viability throughout the entire preservation process.
Plant part for biomolecular research	Spot inspection of biological material quality should be performed regularly, e.g. extract DNA, RNA or other biological molecules for comparable analysis, to check if there is contamination or degradation.

9 Distribution and disposal of biological material

For distribution and disposal of biological material, the biobank shall apply the requirements described in ISO 20387:2018, 7.3.3, 7.5.3, A.7.

10 Information collection

The biobank should document a national or international identification for a donor species for each biological material, where appropriate.

Annex A
(informative)

Typical biological material storage temperatures and storage durations

Table A.1 — Typical temperatures and durations for the storage of different biological material types

Biological material type	Typical storage temperature	Typical storage duration
Silica dried biological material	≤ −80 °C	Long-term storage
Orthodox seeds	5 °C to 10 °C	Medium-term storage
	≤ −20 °C	Long-term storage
Biological material for DNA extraction	≤ −20 °C	Long-term storage
Biological material for RNA extraction	≤ −80 °C	Long-term storage
Biological material for protein extraction	≤ −80 °C	Long-term storage
Fluid-preserved biological material	≤ −20 °C	Long-term storage
Purified RNA	−80 °C	At least 29 months
Purified DNA	−80 °C	At least 7 years
Purified protein	−80 °C	At least 1 year

Annex B
(informative)

Exemplary information table for plant biological material

Table B.1 — Example of a data collection sheet for plant biological material

Data	Example	Description	Requirement or recommendation
Code	HCNGB00001234	The unique storage code of a biological material, e.g. barcode.	Requirement
City	Yushu	City of origin of biological material collection location.	Requirement
Continent	Africa; Antarctica; Asia; Europe; North America; Oceania; South America	The name of the continent in which the location occurs. Recommended best practice is to use a controlled vocabulary such as the Getty Thesaurus of geographic names.	Requirement
Country or state	China	The name of the country or major administrative unit in which the location occurs. Recommended best practice is to use a controlled vocabulary such as the Getty Thesaurus of geographic names.	Requirement
County	Nangqian	The full, unabbreviated name of the next smaller administrative region than the state province (county, shire, department, etc.) in which the location occurs.	Requirement
Disposition	In collection; missing; voucher elsewhere; duplicates elsewhere	The current state of a biological material with respect to the collection identified in collection code or collection ID. Recommended best practice is to use a controlled vocabulary.	Requirement
Family	Rosaceae	The scientific name of the family in which the taxon is classified.	Requirement
Identified by	"person's name"	A list (concatenated and separated) of names of people, groups or organizations who assigned the taxon to the subject.	Requirement
On loan no.		If biological material is currently on loan, the loan number is indicated in the ONLOAN field.	Requirement
Organism ID	HN0076	An identifier for the organism instance (as opposed to a particular digital record of the organism) can be a globally unique identifier or an identifier specific to the data set.	Requirement

Table B.1 *(continued)*

Data	Example	Description	Requirement or recommendation
Biological material copies	2	Number of biological material.	Requirement
Sex	M = male; F = female; H = hermaphrodite; I = hermaphrodite; U = unknown; T = transform	The sex of the biological individual(s) represented in the occurrence. Recommended best practice is to use a controlled vocabulary.	Requirement
Source	Herbarium collection; exchange; donate; purchase; leave with; temporary borrowing; national fine; protection centre handover	Source of a biological material.	Requirement
State province	Qinghai	The name of the next smaller administrative region than the country (state, province, canton, region, department, etc.) in which the location occurs.	Requirement
Storage site	China National GeneBank		Requirement
Altitude	3 358,7		Recommendation
Date of acquisition	2018-05-09	Recommended best practice is to use an encoding scheme, such as ISO 8601-1.	Requirement
Date identified	2018-09-11	The date on which the subject was identified as representing the taxon. Recommended best practice is to use an encoding scheme, such as ISO 8601-1.	Recommendation
Locality	Ranguo Valley	The specific description of the place. Less specific geographic information can be provided in other geographic terms (higher geography, continent, country, state province, county, municipality, water body, island, island group). This term can contain information modified from the original to correct perceived errors or standardize the description.	Recommendation
Habitat	Oak savanna; pre-cordilleran steppe	A category or description of the habitat in which the event occurred.	Recommendation
Verbatim longitude	97°51′55.56″	The verbatim original longitude of the location. The coordinate ellipsoid, geodetic date, or full spatial reference System (SRS) for these coordinates should be stored in verbatim SRS and the coordinate system should be stored in verbatim coordinate system.	Recommendation