



**Absolute Rat Mitochondrial DNA Copy Number Quantification
qPCR Assay Kit
(ARMQ)
Catalog #R8948
100 reactions**

Product Description

Mitochondrial DNA (mtDNA) is circular, multicopy genome DNA located in mitochondrion, a cellular organelle that plays a key role in energy production of the cell. The capacity for energy production in a cell depends on both mtDNA integrity and copy number. Substantial evidence suggests that alterations in mtDNA copy number have been correlated with aging and various age-related disorders, such as cancer, diabetes and neurodegenerative diseases.

ScienCell's Absolute Rat Mitochondrial DNA Copy Number Quantification qPCR Assay Kit (ARMQ) is designed to directly compare the average mtDNA copy number of the samples. The rat mtDNA primer set recognizes and amplifies one of the most conserved regions on rat mtDNA and will not amplify any off-target sequence on nuclear genomic DNA. The single copy reference (SCR) primer set recognizes and amplifies a 100 bp-long region on rat chromosome 17 and serves as reference for data normalization. The reference genomic DNA sample with known mtDNA copy number serves as a reference for calculating the mtDNA copy number of target samples. The carefully designed primers ensure: (i) high efficiency for trustworthy quantification; and (ii) no non-specific amplification. Each primer set has been validated by qPCR with melt curve analysis and gel electrophoresis for amplification specificity and by template serial dilution for amplification efficiency. The 2X GoldNStart TaqGreen qPCR Master Mix (Cat #MB6018a-1) is a SYBR[®]Green dye-based qPCR master mix with a "hot-start" property. It contains SYBR[®]Green, dNTPs, Taq DNA polymerase, and an inert gold-color loading indicator in a single tube. The "hot-start" property achieved through ScienCell's unique chemically modified Taq DNA polymerase provides maximal inhibition of primer dimer formation. The advanced buffer formulation provides superior specificity and efficiency with a wide linear dynamic range. The inert gold-color loading indicator allows for better visualization and tracking of sample loading in qPCR plates or tubes.

Kit Components

Cat #	Component	Quantity	Storage
MB6018a-1	2X GoldNStart TaqGreen qPCR master mix, 1 mL	2 vials	-20°C
R8948a	Rat mtDNA primer set, lyophilized	1 vial	-20°C
R8948b	Single copy reference (SCR) primer set, lyophilized	1 vial	-20°C
8948c	Nuclease-free H ₂ O	4 mL	4°C
R8948d	Reference Rat genomic DNA sample (Lot #33598, mtDNA copy number: 937 ± 20 copies per diploid cell)	100 µL	-20°C

Additional Materials Required (Materials Not Included in Kit)

Component	Recommended
DNA isolation kit	SpeedDNA Isolation Kit (ScienCell, Cat #MB6918)
genomic DNA template	Customers' samples
qPCR plate or tube	

Quality Control

The specificity of the primer sets is validated by qPCR with melt curve analysis. The PCR products are analyzed by gel electrophoresis. The efficiency of the primer sets is validated by template serial dilution (See **Appendices 1 and 2**). The mtDNA copy number of reference genomic DNA sample is determined by qPCR standard curve method (See **Appendix 3**).

Product Use

ARMQ is for research use only. It is not approved for human or animal use, or for application in clinical or *in vitro* diagnostic procedures.

Shipping and Storage

The product is shipped on dry ice. Upon receipt, store the GoldNStart TaqGreen qPCR master mix (Cat #MB6018a-1) in the dark at -20°C in a manual defrost freezer, the primers (Cat #R8948a and R8948b) and the reference genomic DNA sample (Cat #R8948d) at -20°C in a manual defrost freezer, and the nuclease-free H₂O (Cat #8948c) at 4°C. Once thawed, do NOT refreeze GoldNStart TaqGreen qPCR master mix (Cat #MB6018a-1), and keep in the dark at 4°C or on ice at all times.

Procedures

Important: *Only use polymerases with hot-start capability to prevent possible primer-dimer formation. Only use nuclease-free reagents in PCR amplification.*

1. Prior to use, allow vials (Cat #R8948a and #R8948b) to warm to room temperature.
2. Centrifuge the vials at 1,500x g for 1 minute.
3. Add 200 µl nuclease-free H₂O (Cat #8948c) to mtDNA primer set (lyophilized, Cat #R8948a) to make mtDNA primer stock solution. Aliquot as needed. Store at -20°C in a manual defrost freezer. Avoid repeated freeze-and-thaw cycles.
4. Add 200 µl nuclease-free H₂O (Cat #8948c) to SCR primer set (lyophilized, Cat #R8948b) to make SCR primer stock solution. Aliquot as needed. Store at -20°C in a manual defrost freezer. Avoid repeated freeze-and-thaw cycles.
5. For the reference genomic DNA sample (Cat #R8948d), prepare two qPCR reactions, one with mtDNA primer stock solution, and one with SCR primer stock solution. Prepare 20 µl qPCR reactions for one well as shown in Table 1.

Table 1.

Reference genomic DNA sample	1 µl
Primer stock solution (mtDNA or SCR)	2 µl
2X GoldNStart TaqGreen qPCR master mix (Cat #MB6018a-1)	10 µl
Nuclease-free H ₂ O (Cat #8948c)	7 µl
Total volume	20 µl

6. For each genomic DNA sample, prepare two qPCR reactions, one with mtDNA primer stock solution, and one with SCR primer stock solution. Prepare 20 µl qPCR reactions for one well as shown in Table 1.

Table 1.

Genomic DNA template (0.5 – 5 ng/µl)	1 µl
Primer stock solution (mtDNA or SCR)	2 µl
2X GoldNStart TaqGreen qPCR master mix (Cat #MB6018a-1)	10 µl
Nuclease-free H ₂ O (Cat #8948c)	7 µl
Total volume	20 µl

7. Seal the qPCR reaction wells. Centrifuge the plates or tubes at 1,500x g for 15 seconds. For maximum reliability, replicates are highly recommended (minimum of 3).
8. Refer to Table 2 for qPCR program setup. The 2X GoldNStart TaqGreen qPCR master mix (Cat #MB6018a-1) contains SYBR[®]Green as the reporter dye and does not contain a ROX passive reference dye. If the qPCR instrument being used has a "ROX passive reference dye" option, please deselect this option.

Note: The primary factors that determine optimal annealing temperature are the primer length and primer composition. Based on the properties of mtDNA and SCR primer sets (Cat #R8948a and #R8948b), we highly recommend an annealing temperature of 52°C as shown in Table 2:

Table 2.

Step	Temperature	Time	Number of cycles
Initial denaturation	95°C	10 min	1
Denaturation	95°C	20 sec	32
Annealing	52°C	20 sec	
Extension	72°C	45 sec	
Data acquisition	Plate read		
<i>Optional</i>	<i>Melting curve analysis</i>		1
Hold	20°C	Indefinite	1

Figure 1. A typical amplification curve showing the amplification of a qPCR product.

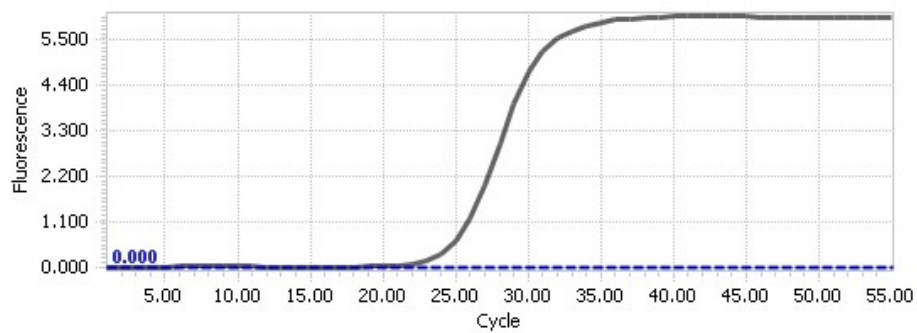
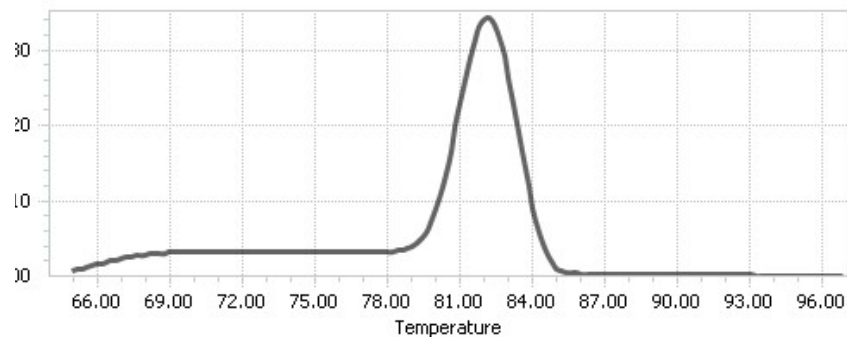


Figure 2. A typical melting peak of a qPCR product.



Quantification Method: Comparative $\Delta\Delta C_q$ (Quantification Cycle Value) Method

Note: Please refer to your qPCR instrument's data analysis software for data analysis. The method provided here serves as guidance for quick manual calculations.

1. For mtDNA, ΔC_q (mtDNA) is the quantification cycle number difference of mtDNA between two genomic DNA samples.

$$\Delta C_q (\text{mtDNA}) = C_q (\text{mtDNA, sample 2}) - C_q (\text{mtDNA, sample 1})$$

Note: the value of ΔC_q (mtDNA) can be positive, 0, or negative.

2. For single copy reference (SCR), ΔC_q (SCR) is the quantification cycle number difference of SCR between two genomic DNA samples.

$$\Delta C_q (\text{SCR}) = C_q (\text{SCR, sample 2}) - C_q (\text{SCR, sample 1})$$

Note: the value of ΔC_q (SCR) can be positive, 0, or negative.

3. $\Delta\Delta C_q = \Delta C_q (\text{mtDNA}) - \Delta C_q (\text{SCR})$

4. Relative mtDNA copy number of sample 2 to sample 1 (fold) = $2^{-\Delta\Delta C_q}$

Example Calculations: Comparative $\Delta\Delta C_q$ (Quantification Cycle Value) Method

Table 3. C_q (Quantification Cycle) values of mtDNA qPCR (mtDNA) and single copy reference qPCR (SCR) obtained for the genomic DNA samples.

<i>Primer set</i>	<i>Target sample</i>	<i>Reference sample</i>
mtDNA	16.41	17.23
SCR	24.64	26.10

$$\begin{aligned}\Delta C_q (\text{mtDNA}) &= C_q (\text{mtDNA, target sample}) - C_q (\text{mtDNA, reference sample}) \\ &= 16.41 - 17.23 \\ &= -0.82\end{aligned}$$

$$\begin{aligned}\Delta C_q (\text{SCR}) &= C_q (\text{SCR, target sample}) - C_q (\text{SCR, reference sample}) \\ &= 24.64 - 26.10 \\ &= -1.46\end{aligned}$$

$$\begin{aligned}\Delta\Delta C_q &= \Delta C_q (\text{mtDNA}) - \Delta C_q (\text{SCR}) \\ &= -0.82 - (-1.46) \\ &= 0.64\end{aligned}$$

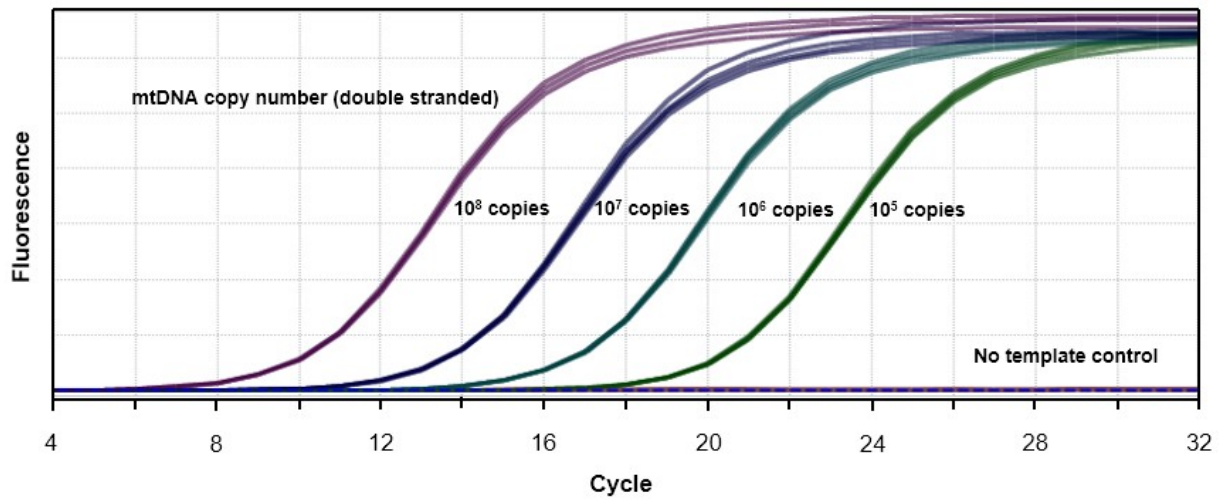
$$\begin{aligned}
 &\text{Relative mtDNA copy number of the target sample to the reference sample (fold)} \\
 &= 2^{-\Delta\Delta C_q} \\
 &= 2^{-0.64} \\
 &= 0.64
 \end{aligned}$$

$$\begin{aligned}
 &\text{The mtDNA copy number of the target sample per diploid cell} \\
 &= \text{Reference sample mtDNA copy number} \times 2^{-\Delta\Delta C_q} \\
 &= (937 \pm 20) \times 0.64 \\
 &= 600 \pm 13
 \end{aligned}$$

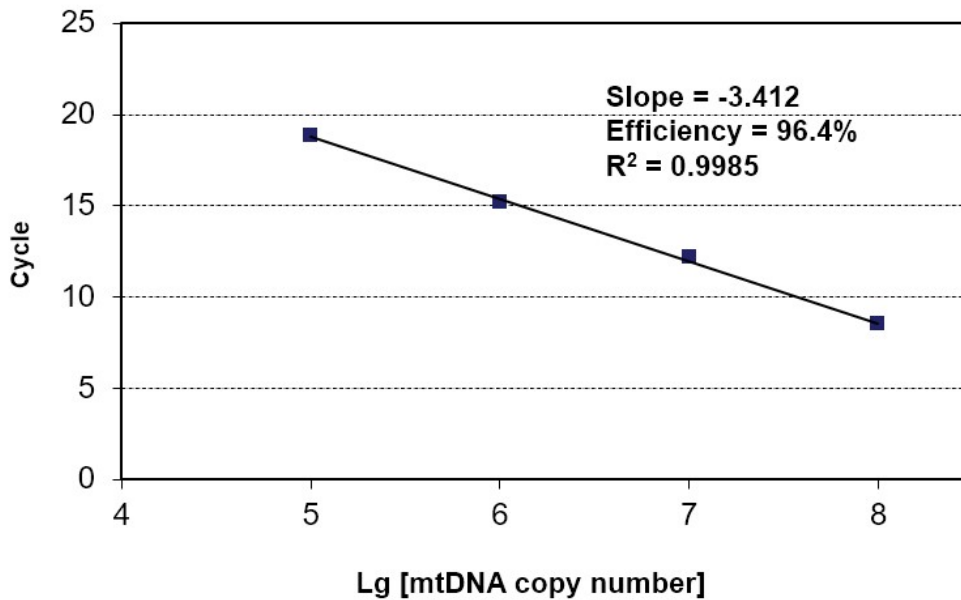
Conclusions: The average mtDNA copy number of target genomic DNA sample is 600 ± 13 per diploid cell.

Appendix 1: Quality assessment of rat mtDNA primer set

A.



B.



C.

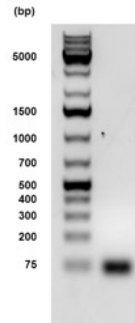
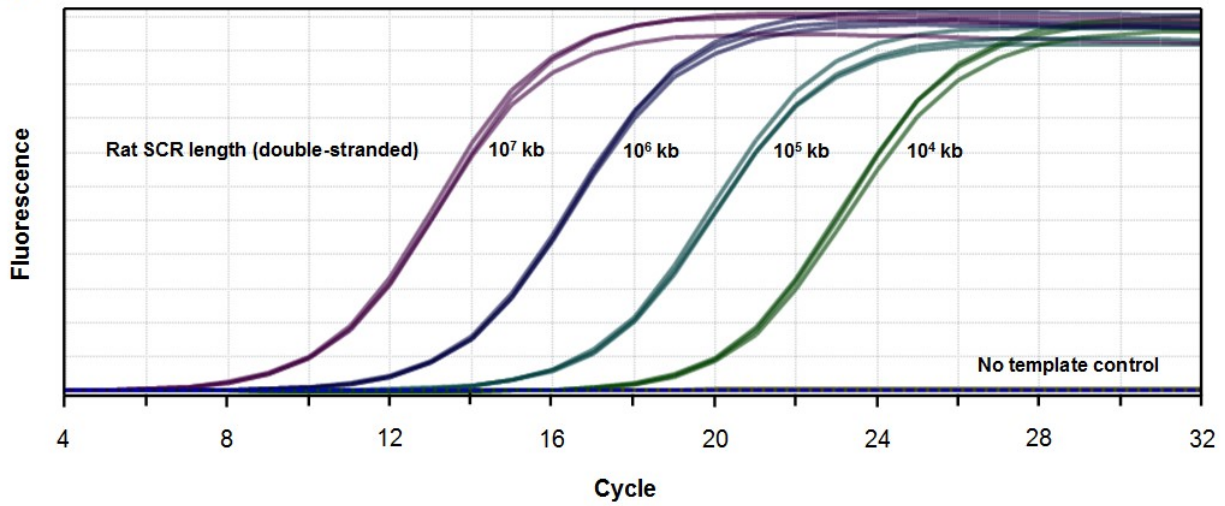


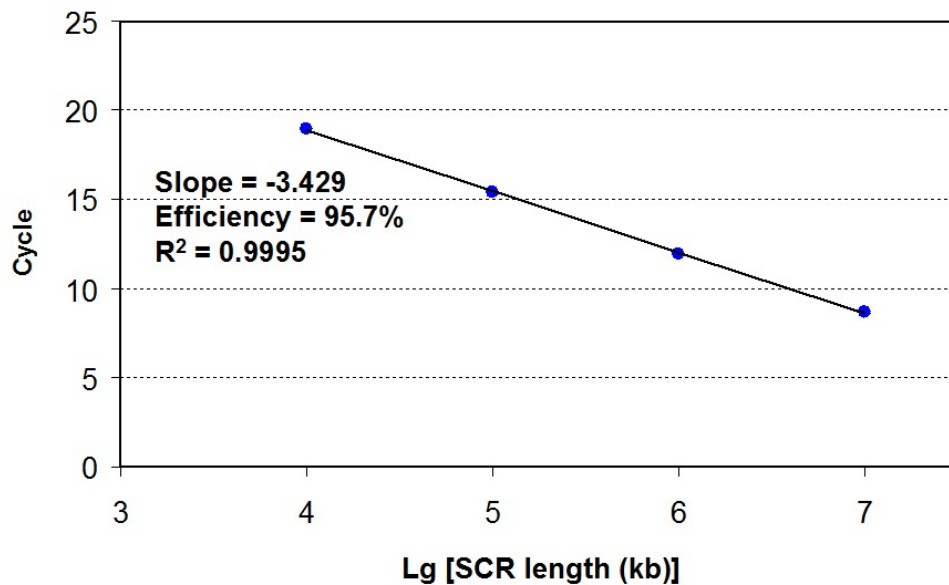
Figure 3. Quality assessment of rat mtDNA primer set. (A) qPCR amplification curves using serially diluted mtDNA template. **(B)** Derivation of qPCR efficiency of mtDNA primer set. **(C)** Separation of mtDNA qPCR product by gel electrophoresis.

Appendix 2: Quality assessment of rat single copy reference (SCR) primer set

A.



B.



C.

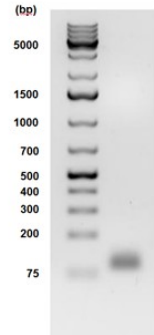


Figure 4. Quality assessment of rat single copy reference (SCR) primer set. (A) qPCR amplification curves using serially diluted SCR template. **(B)** Derivation of qPCR efficiency of SCR primer set. **(C)** Separation of SCR qPCR product by gel electrophoresis.

Appendix 3: Method for quantifying reference rat genomic DNA sample (Cat #R8948d)

To quantify the reference rat genomic DNA sample (Cat #R8948d), a qPCR analysis using it as the template was performed. All experiments were performed in triplicates under the same conditions and repeated at least twice.

Derived from the standard curves in appendices 1 and 2, the mtDNA and SCR copy number of reference rat genomic DNA sample in each qPCR reaction is determined to be:

Total mtDNA copy number (double-stranded): $(372 \pm 8) \times 10^3$ copies

Total SCR length (double-stranded): 79.4 ± 1.4 kb

The SCR template is 100 bp long, therefore, there are 0.2 kb SCR per diploid cell.

Total number of diploid cells = $(79.4 \pm 1.4 \text{ kb}) / 0.2 \text{ kb} = 397 \pm 7$ cells

mtDNA copy number per diploid cell (double-stranded)
= $(372 \pm 8) \times 10^3 \text{ copies} / (397 \pm 7)$
= 937 ± 20 copies

Conclusions: The average mtDNA copy number of reference genomic DNA sample (Cat #R8948d) is 937 ± 20 copies per diploid cell.